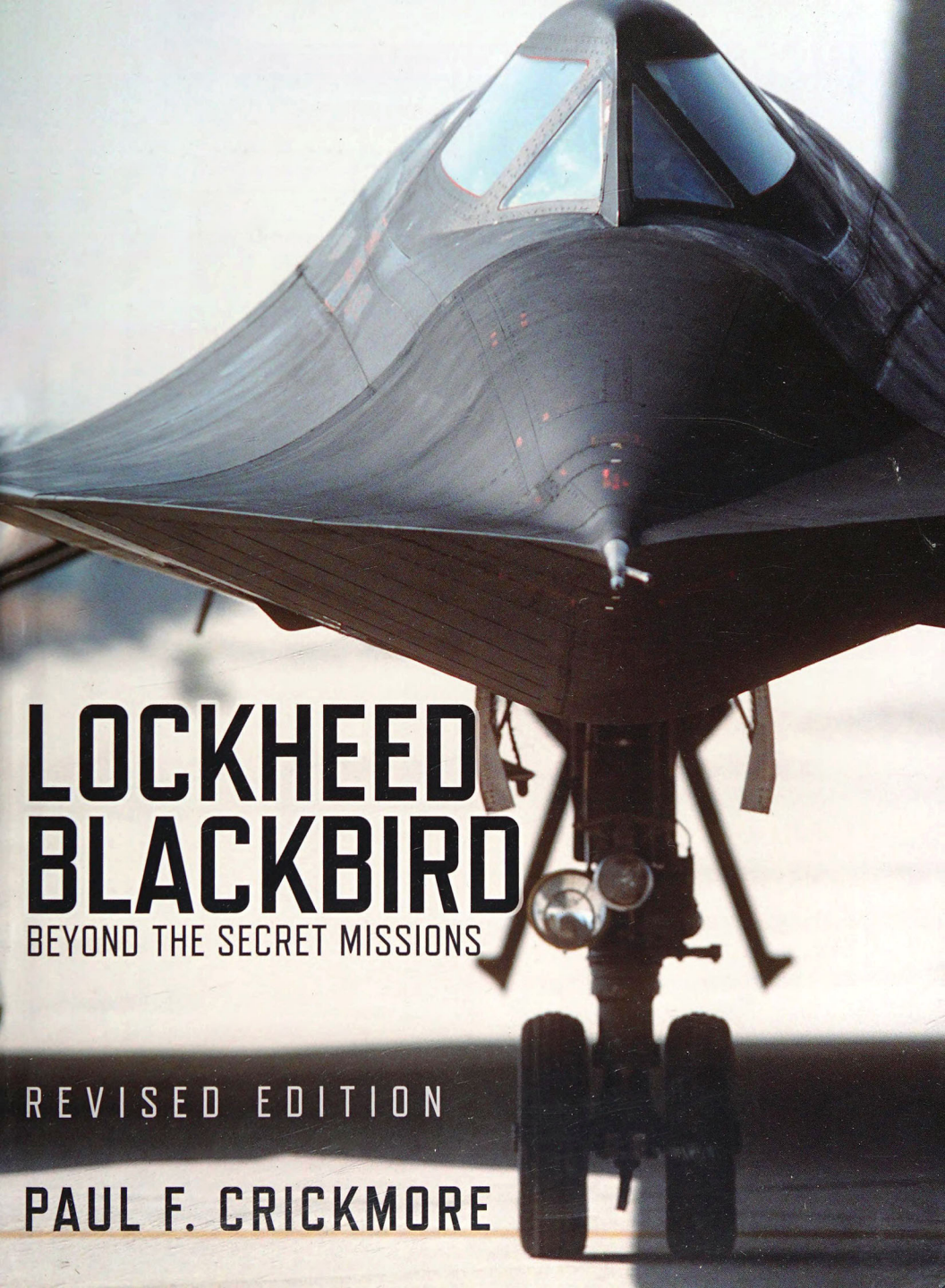

LOCKHEED BLACKBIRD

BEYOND THE SECRET MISSIONS

REVISED EDITION

PAUL F. CRICKMORE

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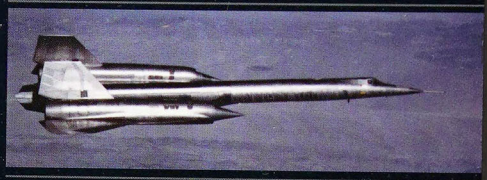

In 1986 Paul F. Crickmore's first ground-breaking book about the Lockheed SR-71 Blackbird was published. At that time, the Cold War was at its height and the SR-71 remained an integral element in securing crucial intelligence from all parts of the globe, with many details still top secret.

Since the end of the Cold War, more and more information has come to light, with a vast number of official documents declassified and key military figures able to talk openly about the Blackbird programme. Paul F. Crickmore has used these newly obtained facts to revise his original history of one of the world's most iconic aircraft, creating what will surely be considered the definitive, timeless volume about the SR-71 Blackbird.

OSPREY PUBLISHING

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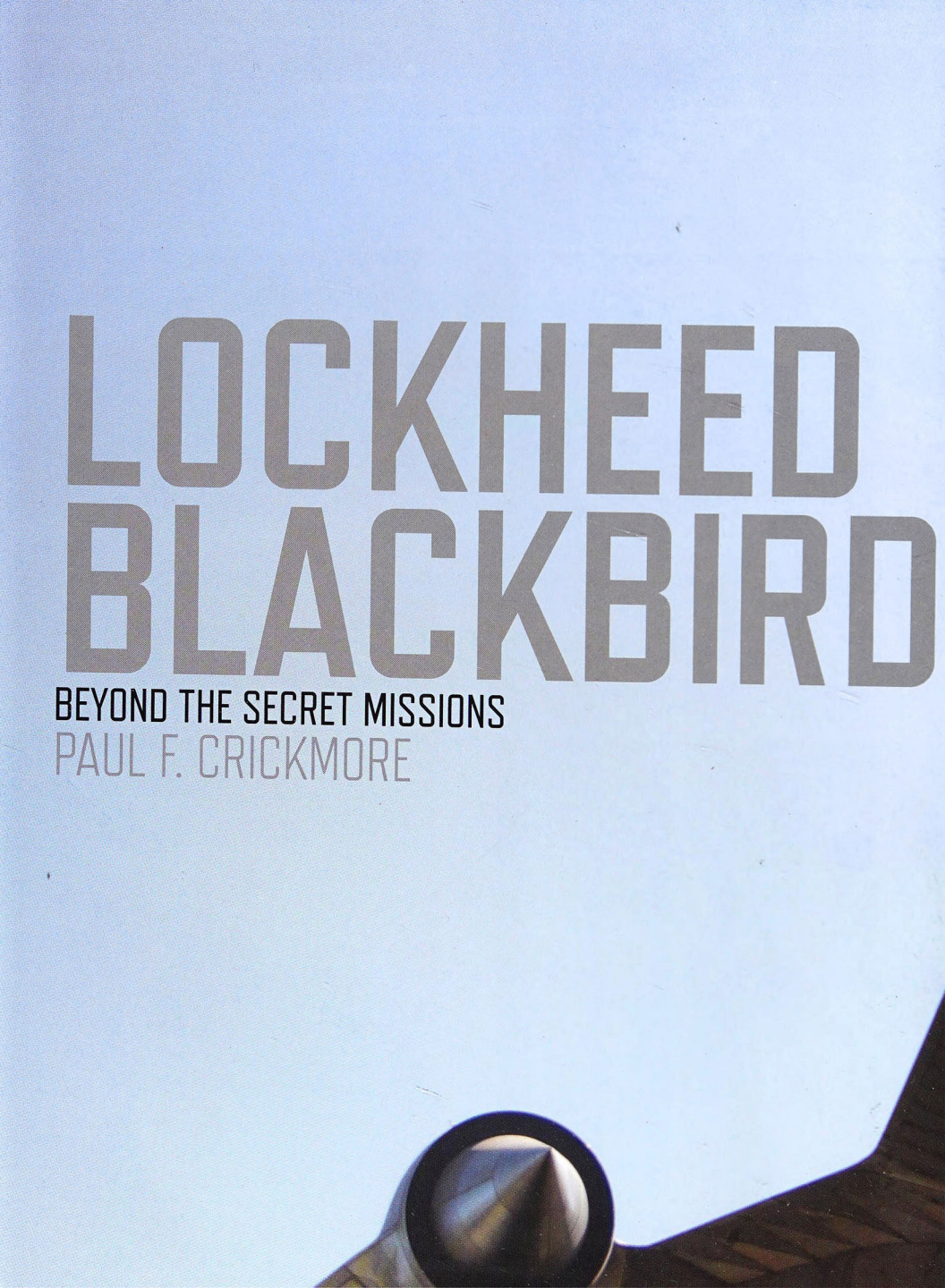

DEDICATION

Dedicated to my wonderful wife Ali with all my love

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Front cover: A 9th Strategic Reconnaissance Wing SR-71 aircraft taxis on the flight line after arriving for its deactivation ceremony. Pilot Terry B. Pappas and reconnaissance officer John D.Manzi have delivered the aircraft to the March Airfield Museum. (US Department of Defense)

Title page: The requirement for an aircraft of omah radar cross section, capable of sustaining 2,200mph, generated the blended contours and distinctive lines of the SR-71. (iStock)

Osprey Publishing supports the Woodland Trust, the UK's leading woodland conservation charity. Between 2014 and 2018 our donations will be spent on their Centenary Woods project in the UK.

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The information contained within this book represents over 30 years of research. During that time literally dozens of crewmembers, maintenance specialists and others intimately connected with Oxcart, Tagboard, Kedlock and the Senior Crown programme have contributed numerous interviews (most of which were held face-to-face, while others were conducted over the internet). As a result, several have become lifelong friends; some unfortunately are no longer with us. To them all, both past and present, I offer my most sincere and grateful thanks.

I would, however, like to single out the following who have been especially helpful: General Pat Halloran; Colonels Rich Graham, Don Walbrecht, Buz Carpenter, Tom Alison and Oxcart pilot Frank Murray; and Lieutenant Colonels Ed Yeilding, Curt Osterheld, BC Thomas Frank Stampf and Jerry Glasser. Also Mike Relja, Tony Landis, Bob Archer, Lindsay Peacock, Lin Xu, Jay Miller, Flight Lieutenant Adam Crickmore, Dr Jeff Richelson and Paul Suhler.

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Thanks are also due to my editors, Marcus Cowper, Paul E. Eden and Russell Butcher. Last but by no means least, my thanks go to Neil, Pauline, Kevin, Jane, Doug and Annie for their endless support.

FOREWORD

Paul F. Crickmore is an acknowledged expert on the history of the fastest and highest-flying operational airplane ever built… the Lockheed SR-71 'Blackbird'. His in-depth research has resulted in a dynamic series of publications that bring life to this marvellous machine, which was so far ahead of its time when it first flew in the early 1960s. Even those of us who flew the Blackbird refer to Paul's publications when we feel a need for refresher information. In the process, we always discover some aspect of engineering or operations that we didn't know (or remember), but which Paul had documented.

He has developed a captivating story of the challenges faced in the early days of the Blackbird programme and the trials of building an airplane capable of performance figures never before achieved. He records the development of new and untried manufacturing processes, employing materials never used in such a manner, and how Lockheed, through the genius of the designer, Kelly Johnson, overcame the basic enemy of all supersonic airplane designs, namely extreme temperatures and airflow management.

The development of the J57 engine by Pratt & Whitney, and the mandatory, companion air inlet system designed by Lockheed, resulted in the first practical turbo/ram jet propulsion system to fly operationally. It allowed the plane to take advantage of Kelly's space-age airframe design to effortlessly cruise above 80,000ft and beyond 2,000mph for unprecedented periods of time. The use of inflight refuelling gave the airplane global range and provided operational capabilities never before seen.

It was the ultimate manned reconnaissance vehicle, capable of quick response to almost any place in the world. It carried a wide variety of the highest technology systems available and could collect invaluable intelligence on film, radar and electronic sensors for exploitation. Its very, very small radar cross section by the standards of the time made it a pioneer in the world of stealth. Its extreme flight altitude not only gave it additional protection from enemy defences, but also provided the capability to observe vast areas of the earth's surface for intelligence gathering. In its latest configuration it was equipped with near real-time sensor downlink to provide 'customers' with immediate tactical information.

Paul's understanding of the many difficulties faced to produce such an operationally ready aircraft, and the engineering breakthroughs required to make it all happen, has allowed him to present to the reader a cogent and in-depth flowing history of one of aviation's greatest achievements. He has again demonstrated his ability to transform what could be a dry, technical textbook of information into an absolutely fascinating and captivating reading experience. It has all the high drama of events that evolved with the development of an airplane with a radical design that had never before been seen, a performance that has not been matched in the 50 plus years since its birth and a legend of operational accomplishment that will never be equalled. It is a tribute to the writing skills of Paul F. Crickmore to have captured this period of aeronautical magic and tied it together into a story of worldwide operations conducted by some of the best, most tightly screened and hand-picked flight crews in the United States Air Force.

After being a fighter pilot for seven years, including 100 combat missions over North Korea, I flew Kelly Johnson's first high-altitude reconnaissance airplane, the U-2, for nine years before moving to the SR-71. I was fortunate to have been selected as a pilot in both airplanes at the very beginning of their operational use by the Air Force. That gave me an

insight into many of the highs and lows of any new programme, examples of which are so superbly captured by Paul in this book. It also gave me a great appreciation for the marvellous aircraft designs and performance capabilities that came from the genius of Kelly Johnson, Lockheed's premier designer of advanced aircraft.

Inside the tightly controlled shops of the famous Lockheed Skunk Works, Kelly and his team of engineers did indeed work magic in the black world of top secret aircraft. I am obviously a Kelly Johnson fan, since I spent the majority of my operational career flying planes designed by him. I was fortunate to have either flown, or flown in, many of his designs, including the P-38, T-33, F-80, F-104, U-2 and SR-71. I therefore have a great appreciation for Paul's ability to bring to you, the reading public, the story of Kelly's greatest challenge and success in aircraft design, the SR-71 Blackbird. This is a book, and a story, that will capture your attention from cover to cover. Paul F. Crickmore, always a prolific writer, has done it again by providing us with a fascinating look into an exotic corner of our aviation world.

Major General Pat Halloran, Colorado Springs, Colorado, USA, July 2016

▲ Major General Pat Halloran. (USAF)

PREFACE

I'd shot off half a dozen films during the course of this KC-135 air refuelling (AR) sortie involving F-15 Eagle receivers from Bitburg Air Base, West Germany. We recovered at RAF Mildenhall and as we taxied slowly back to our allotted stand on the apron I spotted the unmistakable, seductively sleek lines of a Lockheed SR-71. The type had begun operating sporadically out of the English base a few years earlier, but its movements were shrouded in secrecy – this was after all at the height of the Cold War, and its strategic reconnaissance mission was a vital one.

Jumping from the final rung of the tanker's nose ladder, I was immediately met by my escort officer and friend, Maj Jim Morrow. He enquired as to how the sortie had gone, and did I think I'd got some good shots. 'Great', I replied, 'but what are the chances of getting involved in an AR sortie with the Blackbird?' – my mother always maintained I had a long neck! Jim replied that that would be an altogether different affair and the matter wasn't discussed any further.

Some five weeks later, the phone at home rang. At once I identified the 'gravel' voice on the other end as that of Jim Morrow. 'Paul', he said, 'That airplane you were talking about when we last met.' My heart leapt. 'Yes', I replied, knowing precisely what he was talking about and also remembering that we were conversing on an unsecure phone line. 'Can you be outside the Mildenhall main gate at 6:30 tomorrow morning', he continued. As chance would have it, it was my day off. 'Yes', I replied. 'Can I bring my camera?' – that neck again! 'Yes', was the reply, then the line went dead.

So began an association with an aeroplane programme and a remarkable set of people that transcended the wildest dreams of the most optimistic dreamer. My KC-135Q flight, on 6 October 1981, was commanded by Captain Marc Blacketter, and to this day, I've never met anyone who could handle a big jet like him.

Our AR mission was classified secret and the navigation charts were liberally stamped 'Top Secret', but today, long after the tumultuous events of late twentieth century world geopolitics, I can say that we flew in formation with KC-135Q serial 58-0117 to the Viking North air refuelling anchor point off Bodø, northern Norway. Our receiver SR-71A, serial 61-7964, crewed by Capt Rich Judson and Maj Frank Kelly, took on a split fuel load from the two tankers, having already completed its reconnaissance 'take' of the Soviet Northern Fleet, stationed in the ice-free ports on the Kola Peninsula. With fuel tanks once again full, the crew completed their mission with an anti-clockwise loop around the Baltic, before recovering back into RAF Mildenhall. In the refuelling track, my luck had held, despite the northern latitude and time of year, since the clear skies and light conditions were perfect for air-to-air photography and my trusted Canon A1 camera performed flawlessly.

Back on watch at London Air Traffic Control Centre at RAF West Drayton, my dear friend Kevin Gothard – an outstanding controller – badgered me mercilessly about getting the shots published. I eventually plucked up the courage and approached *Air Enthusiast*, which published several. The editor then asked if I was prepared to write an article; I pointed out that this was something I had never done before, but agreed anyway.

Before sending the article off for publication, I passed it by the SR-71 detachment commander of the time, Lt Col Barry McKean, for review. I already had a fair idea what was

sensitive, so when Barry returned the work only a couple of sentences had been removed.

Shortly after the second part of the article had been published, Dennis Baldry – Osprey's larger than life editor at that time – called. He explained that he'd enjoyed my article and had obtained my phone number from *Air Enthusiast*; he then asked if I would write a book about the SR-71! In my supreme naivety (or stupidity), I agreed; however, it's true to say that Dennis really earned his editorial salary knocking that book into shape, producing in the process a highly successful sales generator for Osprey.

In 1990, the SR-71 Senior Crown programme was on the brink of cancellation and Tony Holmes, who had become Osprey's aerospace editor, contacted me and asked if I would undertake a full-scale update of the earlier work. During the intervening period, friends in the SR-71 or Senior Crown programme had provided me with unprecedented access to the Blackbird or Habu, so I talked over Tony's proposal with several of them. They agreed that it was probably time to reveal some of the programme's hitherto classified accomplishments – not least because this might provide wider support for the mortally wounded programme. My good friend and ex SR-71 pilot, Col Don Walbrecht, was central in obtaining further support for my efforts as well as an objective editorial edge to my work prior to submitting it to Osprey. Fortunately, *Lockheed SR-71: The Secret Mission Exposed* was also a great sales success, and then further updated in the spring of 1993, when the programme was finally shut down.

In August 2002, Jane Penrose, Osprey's editorial director, asked if I would again update the book on the basis that the Cold War was now over and even more previously classified material was now available. *Lockheed SR-71: Beyond the Secret Missions* was the result, and happily both the readership and the SR-71 fraternity were extremely complimentary – indeed, Ben Rich, who by that time had taken over from Kelly Johnson, went so far as to salute my work in the acknowledgements of his great autobiography – *Skunk Works*.

This will be my final detailed study of the SR-71 and its associated programmes. I've been given access to yet more declassified documentation, personal diaries, previously unpublished photographs and reconnaissance imagery. This has enabled me to piece together a broader appreciation of the context within which this once highly classified national reconnaissance asset was developed.

Even 30 years after I wrote that first SR-71 article, nuggets of new information continue to emerge, be it about a particular aircraft idiosyncrasy, a clearer insight into why a particular mission or type of mission was flown or a greater appreciation of just who the political and military decision-makers were that granted authority to construct and deploy these iconic, aeronautical masterpieces that made a major contribution to US intelligence gathering while simultaneously making major leaps in mankind's knowledge and understanding of sustained high-altitude, high-Mach flight.

As ever, my aim was to write as detailed, accurate and balanced account as possible, an account that's worthy of being associated with such an amazing programme and some very special life-long friends.

Paul F. Crickmore

INTRODUCTION

The 'Blackbird family' was designed in the late 1950s by aeronautical engineering design genius, Clarence L. 'Kelly' Johnson, and his small team of outstanding engineers at Lockheed's Skunk Works plant in Burbank, California. They were, and remain, the fastest and highest-flying operational jets of all time. Even today, the sleek lines of this flying masterpiece look extremely futuristic, like something that might have featured in a sci-fi movie. What makes the Blackbird's appearance even more remarkable is that its shape isn't the result of thousands of hours of computer modelling, but was achieved by engineers using slide-rules! Its special coat of black paint provides a sinister look, but like everything else about the Blackbird, it was applied for a good reason – to help reduce thermodynamic heating as the aircraft cruised in full afterburner at the outer limits of our planet's atmosphere at more than 2,200mph.

This brings us neatly on to the aircraft's construction. Flying at such extreme speeds the vehicle became incredibly hot – well in excess of 240°C, which is hotter than most household ovens. This ruled out the use of the aluminium alloys used in the manufacture of most other aircraft, because the airframe would have become soft and therefore lose its tensile strength – high performance plastics weren't available in the late 1950s and early 1960s. Instead, titanium was used for the majority of the vehicle. Its use led to numerous construction issues that had to be overcome, indeed Kelly Johnson once said that virtually everything on the aircraft had to be built from scratch. Not surprisingly, it was a high-risk, high-cost programme that required sign-off from the president of the United States.

The high-speed, high-altitude, low-radar return requirement for the aircraft came from the need to build a platform that was capable of conducting the essential but politically sensitive role of strategic reconnaissance – missions that primarily focused on the West's Cold War adversary, the Soviet Union. As a consequence, this often led again to direct presidential involvement when it came to authorizing such missions. By any measure it can be seen that these Mach 3.2 hot-rods weren't your run-of-the-mill military jets.

The crews that flew these amazing aircraft (fewer in number than those involved in the astronaut programme), together with the highly skilled and specialized technicians that serviced the aircraft and its sophisticated operating systems, were also far from run of the mill; they had to be, and they were, the very best of the best. As a result of all these factors, and despite undertaking in excess of 3,500 operational missions over 22 years, often 'in harm's way', not a single Blackbird was lost to enemy action – not though, through their adversaries' lack of trying!

One senior photographic interpreter succinctly encapsulated the essence of the Blackbird's reconnaissance mission when he said, 'Without an outstanding camera package the A-12 and the SR-71 would just be burning very expensive holes in the sky'. Perkin-Elmer, Hycon and others, it will be seen, were more than up to the challenge.

In summary, reconnaissance gathered by the Blackbirds was of national significance, and the intelligence reports formulated from information gained by its sensors were used by the US military and intelligence agencies. These helped the president make decisions upon which US foreign policy, together with political and military posturing, were based. It can therefore be justifiably claimed that the Blackbirds were truly unique and iconic aircraft.

▲ The rigours of high-speed flight even affected the Blackbird's undercarriage. The retracted nose gear was cooled in its bay, while the mainwheel tyres were impregnated with heat-reflecting aluminium. (iStock)

CHAPTER 1

FROM ESPIONAGE TO AQUATONE

Out of necessity, World War II forged an uneasy alliance between two conflicting ideologies, the democratic Western allies and the communist Union of Soviet Socialist Republics (USSR). Together, these two formidable power blocks defeated Nazism, undoubtedly saving the world from a new Dark Age. The carnage of World War II left millions dead and also resulted in a radical change in the appearance of the European geopolitical map. The end of the conflict signalled a cooling of relations between the two great powers, the US and USSR, as suspicion and distrust once again began to escalate.

Winston Churchill remarked, 'An iron curtain… descended across the Continent,' and by 1946 it was apparent that the West faced a new, powerful adversary – its former ally the Soviet Union. Also lined up against the West were a number of former democratic nations in Eastern Europe 'liberated' from the Nazis, but now occupied by the Soviet Union and co-opted into joining the so-called Warsaw Pact. So began a 40-year stand off between the two world superpowers that has become known as the Cold War.

To escape the Nazi Blitzkrieg, the Soviet leadership implemented a radical policy involving the wholesale upheaval and relocation of its

◀ Similar to the aircraft shown here but unarmed, VP-26 PB4Y 59645, coded HB-7, was the first casualty of Cold War intelligence gathering when Soviet fighters shot it down on 8 April 1950. Commanded by Lt John Fette, the aircraft was on a ferret mission over the Baltic, having departed Wiesbaden, West Germany. All ten crewmembers were killed in the attack. (Picciani via Stan Piet)

▲ A typical early Cold War reconnaissance aircraft, converted from WWII bomber stock. This RB-29 was with the 91st SRS at Yokota AB, Japan in 1951. (David Mullen via Warren Thompson)

military bases and heavy industry to the east of the Urals. Therefore, post-war Western maps and target intelligence covering the new threat were woefully inadequate. Returning German prisoners of war (POWs) were one Western intelligence-gathering source, but given the closed nature of Soviet society, the vastness of the country and the level of technology prevailing at the time, the only truly effective option left open to the West was to engage in a programme of aerial espionage.

Thus was born the Peacetime Aerial Reconnaissance Program (PARPRO). Gathering peripheral reconnaissance along the borders of the Soviet Union helped plug some of the intelligence gap, although not without risk. But the only way to produce an accurate US National Intelligence Estimate (NIE) of the Soviet Union's war fighting capability was to overfly it. These overflights were dangerous and highly sensitive, not least because the wilful violation of a sovereign state's airspace runs contrary to international law. Such activity was therefore regulated by the country's highest command authority – the president.

Initially the US Air Force and US Navy performed these reconnaissance, or 'ferret' flights, gathering photographic intelligence (PHOTINT) and electronic intelligence (ELINT) using converted World War II-vintage bombers and patrol aircraft. Stripped of their heavy armour, it was hoped that they'd be able to fly beyond the reach of Soviet interceptors.

In June 1948, the Soviet Union enforced a blockade upon the Western zones of Berlin. The allies responded by mounting a round-the-clock airlift, and the United States highlighted the seriousness of the situation by redeploying bombers to Britain. As allied reconnaissance operations continued, it was only a question of time before they provoked the ultimate response. It occurred on 11 April 1950, when US Navy Consolidated PB4Y Privateer Bureau of Aeronautics Number (BuNo) 59645, nicknamed *Turbulent Turtle* and operated by VP-26, with a crew of ten on board, was shot down and crashed into the Baltic, off Soviet-occupied Latvia.

World destabilization continued when, at dawn on 25 June 1950, communist North Korea invaded its southern neighbour, sparking the Korean War. Meanwhile, back in Europe, surveillance operations against the USSR continued: the 5th Strategic Reconnaissance Group (SRG), from Travis AFB, operated Boeing RB-29s from RAF Sculthorpe and Burtonwood. Like the de Havilland Mosquitos flown by the RAF (Royal Air Force), their high-altitude performance and long range made them ideal PHOTINT and ELINT platforms.

In February 1951, RB-45 Tornados from Strategic Air Command's (SAC's) 322nd, 323rd and 324th Strategic Reconnaissance Squadrons (SRSs), 91st Strategic Reconnaissance Wing (SRW), based at Lockbourne AFB, Ohio, began rotating through RAF Sculthorpe on three-month temporary duty (TDY) assignments. They flew along the periphery of the USSR and occasionally over Soviet satellite countries. Later, four of these Tornados were 'loaned' to

Great Britain and painted in RAF markings.

On the night of 21 March 1952 one of these aircraft, flown by an RAF crew, ventured into East Germany to gage how the Soviets would react to such an incursion. Suitably encouraged, allied planners put together an audacious mission that was implemented on the night of 17 April 1952. Three RB-45Cs in RAF colours and similarly crewed, departed Sculthorpe, each heading for a separate air refuelling track: one was located over the North Sea, another over Denmark and a third south of Frankfurt.

Having finished tanking from US Air Force KB-29s, they climbed to 35,000ft and proceeded in total radio silence on routes that took them deep into the Soviet Union and designed to overfly the maximum number of targets possible. One aircraft covered points in Estonia, Latvia, Lithuania, Poland and the former German province of East Prussia; another flew across Belorussia as far as Orel; and the third, piloted by Squadron Leader John Crampton, flew the longest and most southern route, crossing the Ukraine and penetrating 'denied airspace' as far as Rostov on the Black Sea before returning safely back to Sculthorpe after a flight lasting ten hours 20 minutes. The operation was judged a success and a similar mission was flown, again by three 'RAF' RB-45s, on 28 April 1954. The RAF then exited its brief and highly classified relationship with the Tornado (the US 19th Tactical Reconnaissance Squadron (TRS) flew a similar three-ship mission sometime later, after SAC) had retired the aircraft from its inventory).

Perhaps not surprisingly, the Soviet Union was becoming increasingly sensitive to Western incursions into its airspace, and retaliated by pressing home a series of attacks on any aircraft suspected of violating its sovereignty. In April 1952, an Air France DC-4 was attacked and damaged in the Berlin corridor, and less than two months later a Swedish Air Force C-47 was downed into the Baltic Sea east of Gotland. Even a search and rescue PBY Catalina was attacked while looking for survivors. The Russians certainly meant business, as witnessed at 17:33 local time on 13 June 1952, when RB-29 44-61810, assigned to the 91st SRS and operating out of Yokota AB, Japan, was shot down by two MiG-15s of the 165th Air Division of the Naval Air Force, stationed at Unashi. The entire 12-man crew aboard the reconnaissance aircraft was lost.

Virtually a repeat performance followed at 14.30 local time on 7 October 1952, when RB-29 44-61815, named *Sunbonnet King* and also from the 91st SRS, was destroyed by two Soviet La-11 fighters from the 368th Air Defence Fighter Aviation Regiment while conducting a reconnaissance mission north-east of the island of Hokkaido, Japan. All eight crewmembers were killed.

The effort to identify alternative methods of securing reconnaissance of the Soviet Union began in 1951, when a federally funded research and development centre of the Massachusetts Institute of Technology (MIT) was established at the Lincoln Laboratory. Initially the lab focused on improving the nation's air defence system through advanced electronics. However, this remit was broadened when the Air Force required assistance that would enable SAC to develop innovative ways of procuring target information from behind the Iron Curtain.

As a result, the Air Force's Deputy Chief of Staff for Development, Major General Gordon P. Saville, added 15 reconnaissance experts to Project Lincoln, an existing project on air defence. The Boston-based study group acquired its 'Beacon Hill' code name from the headquarters within which it was based – a nondescript room located above a secretarial school on Beacon Hill, in Cambridge, Massachusetts. It was chaired by Kodak physicist Carl Overhage, and first assembled in May 1951. Its members included physics Nobel Laureate Dr Edward Purcell and Dr James Baker (both from Harvard), Saville Davis from the Christian Science Monitor, Allen F. Donovan from the Cornell Aeronautical Laboratory, Peter Goldmark from Columbia Broadcasting System Laboratories, Dr Edwin Land, founder of

the Polaroid Corporation, Stewart Miller of Bell Laboratories, Richard Perkin of the Perkin-Elmer, and Dr Louis Ridenour, chairman of the scientific advisory board to the chief of staff, United States Air Force. Wright Air Development Center (WADC) sent Lt Col Richard Leghorn along to serve as its liaison officer.

On 15 June 1952, the group submitted its 14-chapter report to the Air Force. It advocated radical approaches to obtaining the information urgently required by the US intelligence community in order to compose robust and accurate NIEs, and covered covert radar, radio and photographic surveillance. The report also examined the use of passive infrared and microwave reconnaissance, together with the development of advanced reconnaissance vehicles. One of its key recommendations called specifically for the development of high-altitude reconnaissance aircraft.

The idea of a purpose-built reconnaissance-gathering aircraft was a concept being contemplated by US Air Force Maj John Seaberg, an engine specialist serving as assistant chief in the New Developments Office, Bombardment Branch, at Wright Field, near Dayton, Ohio. He proposed mating an aircraft with an extremely efficient high-aspect-ratio wing to the new generation of turbojet engines currently under development. Such a union should, he believed, create a platform able to cruise at altitudes far in excess of any other aircraft then in service. Spurred on by his new boss, William Lamar, Seaburg had by March 1953 created a formal specification, requiring the aircraft to cruise at an altitude of 70,000ft and possess a range of 1,500nm while carrying a camera payload weight of up to 700lb. Furthermore, he proposed that the new aircraft should be in service by 1956.

Prompted by the Beacon Hill report, the USAF formally requested design studies for a specialized reconnaissance aircraft on 1 July 1953, based on the specification that Lamar and Seaberg had developed at Wright Field. These initial proposals were subsequently released to just three of the smaller aircraft manufacturing companies – another idea promoted by Seaberg, his rationale being that since large-scale production was not envisioned, the project would receive a much higher priority than if placed with the big players.

Consequently, Bell and Fairchild were requested to submit proposals for the design and construction of a totally new aircraft; Martin, however, was asked to produce a stopgap by applying improvements to its B-57 (a design built under licence from the British English Electric Company). During July 1953, six-month study contracts were agreed with each company and the project, now identified as MX-2147, was given the classified cryptonym 'Bald Eagle'.

On 20 November 1953, recently retired USAF Col Jack Carter, now working for Lockheed in its development planning office, handed a paper he'd just completed to his boss, Gene Root. Both men had previously worked at the Pentagon in an office named USAF Development and Advanced Planning (AFDAP), which set development and planning objectives for various missions. Carter's memo, entitled *Strategic Reconnaissance* and classified 'eyes only', outlined the urgent need for a new type of manned reconnaissance aircraft. It pulled no punches; the target was the Soviet Union and the aircraft he was proposing should be capable of overflying that country at extreme altitude – between 65,000 and 70,000ft. Carrying a reconnaissance package of up to 500lb, the design would need to be radical to save weight, with a load factor as low as 2.25g (the military norm was more akin to 7g). In addition, the single-seat, turbojet-powered aircraft should have a maximum indicated airspeed of just 225–250kt and, in a bid to save weight, there would be no landing gear – just a bogie for take-off and a skid upon which to land.

Both men realized that the ideal group to work on such an unconventional aircraft was also located at Lockheed, within a small, limited access department known as Advanced Development Programs (ADP). The department also went by a nickname – the Skunk Works.

◀ Aeronautical engineering genius and Skunk Works boss Clarence L. 'Kelly' Johnson pictured with two of his designs. The CIA U-2C at left is sporting a 'civilian' registration. These were applied in late 1960 following the Gary Powers shootdown, and were therefore in place when flights over Cuba began. The other aircraft is an F-104 Starfighter. (Lockheed Martin)

This small manufacturing facility had come into being back in 1943, following Lockheed's successful bid to build the United States' first jet fighter. It was headed up by aeronautical design genius Clarence L. 'Kelly' Johnson. He recruited the finest engineers from the Burbank facility and put them to work in an area isolated and secure from the rest of the plant, building the XP-80 Shooting Star in just 143 days. The high level of secrecy surrounding the facility's activities, together with its position – adjacent to the unit's awful-smelling plastics manufacturing plant – caused Ervin Culver, a talented engineer on Kelly's team (who later invented the rigid rotor system for helicopters), constantly to answer the telephone using the name 'Skunk Works' after a location in a popular war-time comic strip written by Al Capp – the name stuck.

Once the initiative had been handed to Kelly Johnson, he realized that the reconnaissance requirement outlined by Carter could be met by modifying the fuselage of an F-104 Starfighter (an aircraft he and his team of Skunk Works engineers had just designed) and marrying it to a new high-aspect, low-thickness ratio wing. By 5 March 1954, Johnson and his small team had designed the CL-282, powered by a General Electric J73 turbojet and likely to reach 73,000ft at the end of its cruise climb from 65,000ft, have a radius of action of 1,400nm and a payload of 600lb.

By January 1954, Bell, Fairchild and Martin had completed their studies and submitted them to Wright Field for evaluation. Apart from all three companies nominating the new Pratt & Whitney J57 axial-flow turbojet engine (with high-altitude modifications, its full designation would become J57-P-37), the designs varied considerably. As requested, Martin's proposed Model 294 was a 'big wing' version of the B-57. Bell's Model 67 was a frail-looking twin-engined craft, while the single-engined Fairchild M-195 featured an over-the-fuselage intake and a stub-boom mounting for vertical and horizontal tail surfaces.

By March 1954, the Air Force engineers at WADC had nominated Martin's B-57D as the interim design, while the Bell proposal was felt to be the more suitable long-term design, not least because the team couldn't bring themselves to approve Fairchild's single-engine concept for such a mission. In April, Seaberg briefed all three designs to commanders at Air Research and Development Command (ARDC) in Baltimore, and SAC. This was followed a month later by yet another briefing, this time to Air Force Headquarters in Washington DC. Shortly

▲ Francis Gary Powers pictured wearing the partial pressure suit worn by pilots flying all early U-2 variants. He is shown here after his release by the Soviets in February 1962, having been signed on by Lockheed as an engineering test pilot. (Lockheed Martin)

afterwards Seaberg received approval to proceed with the B-57D. Consequently a list of B-57 modifications was sent to ARDC headquarters to enable urgent Air Force intelligence requirements in Europe to be met. Tentative approval was also obtained for the Bell Model 67 design.

Meanwhile, Johnson had sent his CL-282 design to Col Bennie Schriever at the Pentagon in early March 1954 as an unsolicited proposal. Schriever was extremely interested and requested a specific proposal from the Skunk Works boss. A month later Johnson was in the Pentagon promising to take complete responsibility for the programme, including production and field support of 30 aircraft. However, four Air Force generals present at the meeting (including Lt Gen Donald Putt, the outgoing commander of ARDC) were less than enthusiastic. In early June 1954, HQ USAF wrote to Johnson rejecting his CL-282 design on the basis that it was too radical, was single-engined and that they'd already committed to other proposals. Such an unequivocal rejection could easily have spelled the end of the line for the Skunk Works proposal were it not for a small group of high-powered individuals serving on various highly influential government advisory boards.

In October 1954, the Office of Defence Mobilization's (ODM's) Surprise Attack Committee (the ODM was an independent agency of the US government whose function was to plan, coordinate, direct and control all wartime federal government mobilization activities) established the Technological Capabilities Panel (TCP) under the chairmanship of Dr James Killian, president of MIT. As an offshoot of Eisenhower's own Science Advisory Committee, TCP members worked in the Executive Office and reported directly to him. Killian subdivided his panels' work into three projects.

Project One focused on offensive capabilities, Project Two on the application of technologies to defence, and Project Three on intelligence. He invited Edwin Land (who had sat on the Beacon Hill group) onto the steering group committee and asked him to chair the TCP's Project Three. Land then selected his project's membership, which fluctuated over the course of the coming years but included many that had served on previous advisory bodies for overhead reconnaissance. The original panel consisted of Allan Latham (from Polaroid), lens designer Dr Jim Baker and Ed Purcell (both from Harvard), chemist Joseph Kennedy from Washington University and John Tukey of Princeton and Bell Telephone.

Other key individuals also helped shape US airborne reconnaissance policy, including Trevor Gardner. Personally appointed by Eisenhower as Assistant Secretary of the Air Force for research and development (R&D), Gardner had also served on the Beacon Hill group; he'd attended the Pentagon meeting during which Johnson had presented his CL-282 design and was impressed. Another was Philip Strong, a leading Central Intelligence Agency (CIA) analyst and the operations chief within the Office of Scientific Intelligence (OSI) of the CIA.

While serving on an Intelligence Systems Panel (ISP), which was part of the USAF's Scientific Advisory Board, Land and Strong were made aware of the CL-282 and Bald Eagle designs. By late October 1954, Land's group had not only concluded that the CL-282 must be built, but had made the equally radical decision that the military should not 'engage

directly in extensive overflight' and that such a task was more suited to the CIA, which 'as a civilian organisation [could] undertake (with the Air Force's assistance) a covert program of selected flights'. However, when Land and Gardner went to see Director of Central Intelligence (DCI) Allen Dulles, he was less than impressed with their proposal. The DCI saw the 'Agency' as an espionage and analysis operation, and this proposal stretched way beyond such a remit. But when Land and Killian went to see Eisenhower shortly afterwards, they were heartened when, after some tough questioning, he endorsed the Land Panel's approach. Having served with distinction as a former army four-star general and Supreme Allied Commander Europe, Eisenhower was acutely aware of the political implications of directly linking such overflights to the military should an incident occur and the pilot be captured by the Soviets.

A letter from the TCP to DCI Dulles, dated 5 November 1954, therefore recommended that the CIA establish a programme of photo-reconnaissance flights over the USSR with the assistance of the Air Force. In a subsequent meeting, held on 19 November in the office of the Secretary of the Air Force, Harold Talbott, the CIA and USAF agreed to pursue the TCP's proposal on a joint basis. This was followed up four days later by a memorandum signed by members of the Intelligence Advisory Committee (IAC) in support of the photo-reconnaissance programme.

On 18 November General Donald Putt, who had moved from ARDC to become Deputy Chief of Staff for Development, brought John Seaberg to the Pentagon from Wright Field to brief the TCP scientists on the USAF perspective. Seaberg grudgingly conceded that the Lockheed design was 'aerodynamically close' to the Bell and Fairchild designs that he had sponsored. But he insisted that the J73 engine 'would not be good enough to do the job in Kelly's airplane'.

Summoned by Trevor Gardner, Kelly Johnson arrived the next day to meet General Putt in the presence of Land's group. Johnson soon dispelled any lingering doubts about his design that the scientists may have had, although he did reluctantly agree to re-engine his C-282 with the Pratt & Whitney J57 and rethink the lack of landing gear.

The Killian Committee's decision to back the refined CL-282 proposal was communicated to Secretary of Defence Charles Wilson and DCI Dulles. On 24 November, a meeting was held at the White House with President Eisenhower to present and seek authorization for the CL-282 proposal, and request funds to produce 20 aircraft at a total cost of $35 million. This was duly sanctioned.

That same day, Kelly received a phone call giving him the go-ahead for the project, which was accorded the classified cryptonym 'Aquatone' (during the Agency's association with the U-2, which finally ended on 30 July 1967, the cryptonym changed on two occasions in order to preserve security when this was believed to have been compromised. It therefore became 'Chalice' on 1 April 1958 and 'Idealist' on 15 May 1960, following the U-2/Gary Powers shootdown). Within days the Skunk Works had by default become a full-scale, advanced-design engineering and production facility.

The requirement for absolute secrecy meant that in the years ahead, the Skunk Works team was assured a high degree of autonomy from the rest of the Lockheed Corporation; additionally, the high level of specialized support required to run the programme, coupled with the lack of CIA expertise in this field, ensured Lockheed's participation in the programme for the life of the aircraft. In one step, a series of precedents had been set for future aircraft programmes.

On 1 February 1954, Richard Bissell Jr (a brilliant economist who lectured at Yale and MIT) was named Director for Planning and Coordination by DCI Allen Dulles. In order to preserve the secrecy that Eisenhower and Dulles insisted upon, Bissell suggested locating Aquatone in a 'stand-alone organization rather than as part of an existing CIA directorate'.

The resulting Development Projects Staff (DPS) was the only CIA component with its own communications office and 'operational cable traffic'. Headquarters for the project was moved to a suite of offices in the Matomic Building at 1717 H Street, Washington DC.

Later that year, in response to congressional criticism of the CIA, the Hoover Commission established a Special Study Group, chaired by Gen James Doolittle, to investigate the agency's covert activities. When it reported back on 30 September, it expressed the belief that every known technique should be used, and new ones developed, to increase US intelligence by high-altitude photographic reconnaissance and other means.

The team Kelly recruited to design and build the new reconnaissance aircraft included Dick Boehme (project engineer), Art Viereck (head of manufacturing), Ed Baldwin and some 50 other key engineers. Kelly nominated Tony LeVier (chief test pilot on the XF-104) to be the project's chief test pilot and his first task was to find a secret site from which to conduct flight tests. Edwards and Palmdale were initially considered, but soon discounted by the US government, which deemed them too visually accessible to the public.

In response, LeVier and Dorsey Kammerer, a Skunk Works' logistics specialist, borrowed the company Beech Bonanza and conducted a two-week aerial survey of remote desert areas in southern California and Nevada. They then submitted a short list of possible options; none appealed to Bissell or Col Ozzie Ritland, the USAF's liaison officer to the U-2's DPS. To settle the issue, in mid-April 1955 LeVier used the Bonanza to fly Johnson, Bissell and Ritland up to some likely sites near the Nevada nuclear test range. Ritland, a pilot who was once assigned to the B-29 test squadron that had dropped nuclear weapons at the range, directed LeVier towards an old WWII airfield that he remembered just to the north of the test range and adjacent to Groom Dry Lake. They landed on the lakebed and, according to Ritland, 'within 30 seconds we knew it was *the* place'.

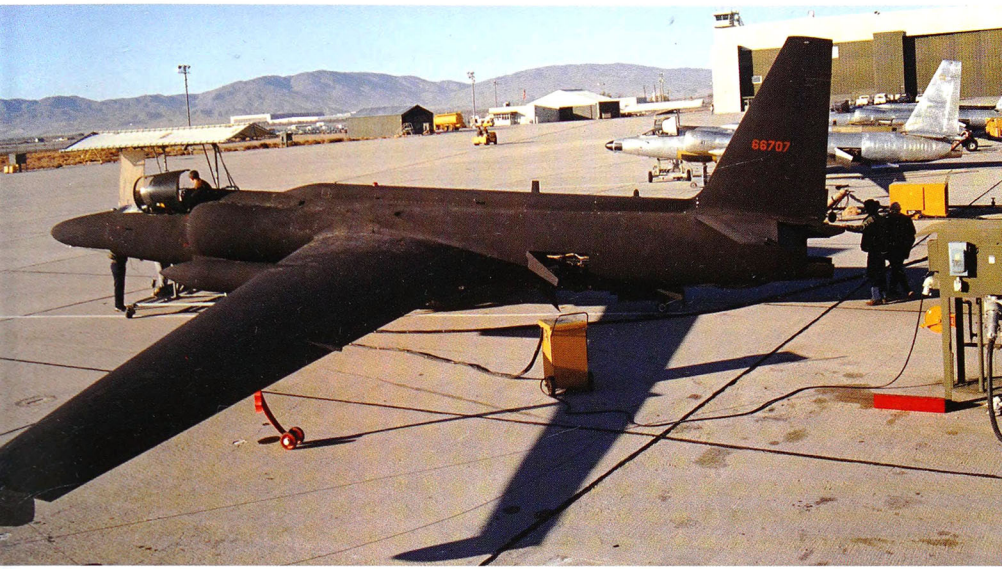
In early May 1955, the DPS issued contracts worth $800,000 for construction work at the secret site. It was to consist of a 5,000ft runway, control tower, mess hall and three hangars. Johnson, with generous amounts of irony, euphemistically referred to this parched desert location as Paradise Ranch, soon inevitably shortened to 'The Ranch'.

On 7 May 1956, an elaborate cover story, devised to mask the true purpose of the U-2 programme, was issued to the press in the name of Dr Hugh Dryden, director of the National Advisory Committee for Aeronautics (NACA), the predecessor of the National Aeronautics and Space Administration (NASA). It announced that the first U-2 aircraft were participating in an upper atmosphere research programme and 'flying from Watertown Strip in Southern Nevada'. Watertown had become the 'official' title for The Ranch, the CIA naming it after the town in upstate New York in which its DCI, Allen Dulles, was born.

Part of the vast Nevada test site had been a WWII gunnery range and a walk across the lakebed revealed countless spent 50-cal rounds, shell cases and links. Divided into many areas, the site fell within the boundaries of the main Atomic Energy Commission (AEC) nuclear test site. Therefore the area had to be cleared, fenced off and a restricted airspace zone established. Within three months, under the auspices of Richard Bissell, a large team of AEC construction crews was working around the clock to transform the site into a basic test facility.

To ensure that 'Kelly's Angel' (as the high-altitude design was being referred to by some in the Skunk Works) kept ahead of its rival the Bell 67 (now officially designated X-16 by the Air Force as a cover), Johnson promised that his design would be airborne no less than 8 months after first metal was cut. The initial batch of 20 aircraft was built at the Burbank plant; thereafter further production was moved to Oildale, near Bakersfield, California.

On 15 March 1955, wind tunnel testing had been successfully completed and on 21 May, the fuselage of 'Article 341', the prototype, was removed from its jig. On 20 July, the completed aircraft was handed over for final checks. The next day it was disassembled and placed into



loading carts. At daybreak on 24 July, Article 341 was moved into an Air Force C-124 and flown to Watertown. There it was reassembled in the semi-completed hangars, and three days later static engine runs were initiated.

After taxi tests – the third of which culminated in the aircraft inadvertently getting airborne to a height of 35ft – the scheduled first flight took place at 15:55hrs on 4 August 1955. Witnessed by several key Skunk Works and Agency people, Tony LeVier (using the call sign ANGEL 1) was chased by a Lockheed-operated C-47, flown by company test pilot Bob Matye and accompanied by Kelly Johnson (Matye became the second pilot to fly Article 341).

It was during these early stages of the flight test programme that the aircraft was officially designated U-2, 'U' being the USAF prefix used to designate utility aircraft; another deception designed to hide the aircraft's true mission. Bell's X-16 had also been progressing well, with construction getting under way in September 1954 and its first flight scheduled for early 1956. However, with the Agency, not the Air Force, now responsible for high-altitude reconnaissance, the X-16's *raison d'etre* had disappeared. Consequently, two months after the U-2 took to the air, a decision was made to terminate the X-16 contract. It was a bitter blow for Bell and one that had serious financial implications for the company for several years.

The first of six RB-57s was delivered to SAC under Project Black Knight in March 1956. The aircraft went to the 4025th SRS, 4080th SRW at Turner AFB, Georgia, which conducted its first operational deployment under Operation *Sea Lion* just four months after activation. Most of these early operations were electronic intelligence/signals intelligence (ELINT/SIGINT) missions flown from operating locations (OLs) at Yokota AB, Japan and briefly Eielson AFB, Alaska.

Highly classified, these ferret sorties employed specialist equipment designated Model 320 or Semi-Automatic Ferret Equipment (SAFE), which had been tested during 1956 and 1957 under the Blue Tail Fly project; thereafter it was declared operational and deployed on board the RB-57s. In addition, the unit conducted high-altitude sampling, during which particles were collected from the upper atmosphere following nuclear tests undertaken by

▲ Pictured at Site 2, Palmdale, circa 1972, these U-2C aircraft were being reconfigured with the Advanced Location and Strike System (ALSS). Adaptability and low operating costs have ensured that the U-2 continues to make a vital contribution to intelligence gathering. For identification purposes, the two bare metal aircraft have the last two digits of their article number painted on the intake – 347 and 367. (Lockheed Martin)

China and the Soviet Union. This enabled scientists to ascertain weapon characteristics, including yield and efficiency.

In February 1957, the 4025th relocated from Turner to Laughlin AFB, Texas and one month later it received the last of 20 RB-57Ds ordered by the Air Force. For six months further air-sampling flights were conducted, this time from Eniwetok Proving Grounds in the Marshall Islands. Then, in early 1959, under Operation *Bordertown*, the unit deployed to Europe, where it continued to conduct air sampling and ELINT/SIGINT missions, before returning to Laughlin and deactivating in mid-1959.

By 1 September 1955, Tony LeVier had completed 20 flights in the U-2, but left Project Aquatone for Burbank, having been promoted to Director of Flying. Future test flight planning became the responsibility of Ernie Joiner, and Bob Matye and Ray Goadey undertook the flying.

CAMERAS AND CREWS

The mission payload of early-model U-2s was held in a cavernous pressurized area behind the cockpit, known as the Q-bay. The acquisition of PHOTINT was to be the aircraft's primary mission and Dr Jim Baker proved pivotal in the conceptualization of its camera systems. Three were worked up. Type A was primarily refurbished Air Force stock and a stopgap. The Type C, with its 180in. focal-length lens, was overtaken by events, while the Type B camera became Project Aquatone's workhorse.

Using a 36-in. focal-length lens, its large-format film (18×18in.) was loaded onto two 6,500ft rolls. When the system was activated, the camera imaged onto two 9½in.-wide frames through a single lens, thereby providing very high-resolution, stereo coverage of the collection area with a 50–70 per cent overlap. Manufactured by the Hycon Corporation, the Type B camera system weighed about 500lb including film. Also located in the Q-bay was a 35mm tracking camera. This scanned from horizon to horizon throughout the flight, providing the photographic interpreters with an accurate ground track of the aircraft's flight path.

Pilots recruited into Project Aquatone by the Agency came straight from the Air Force on a 'suspended contract'; their 'grey suit' time during the period of 'secondment' counted as time served in the military. Having passed various interviews, conducted by mysterious civilians at insalubrious hotels, they then spent a week undergoing one of the most rigorous medicals ever devised, at the specialist Lovelace Clinic, Albuquerque, New Mexico. In all, about 25 pilots, in three intakes, were recruited into the Agency programme.

During the Geneva Summit on 21 July 1955, President Eisenhower had proposed that an 'Open Skies' plan be considered between the United States, the Soviet Union and other participating countries, wherein a limited number of annual reconnaissance overflights would be made in order to verify claims of declared force strengths. Surprised by the proposal, the Soviet delegation reacted favourably and agreed to confer with their Party Secretary, Nikita Khrushchev. However, his paranoia and deep mistrust of the West conspired to ensure that he neither signed up to, nor rejected, the proposal. Such prevarication ensured that Open Skies failed one month later, when a vote was taken in the United Nations. By June 1956, the initial flight test and training objectives of Aquatone had been completed, and six pilots, together with ten U-2s, were readied for operational deployment. Operation *Overflight*, the contingency plan to Eisenhower's Open Skies proposal, was ready.

A major factor that had influenced Eisenhower in his decision to authorize *Overflight* was a US NIE issued while the U-2 was being developed. It noted that 'although the Soviets have made great strides in radar development', their standard S-band V-band early warning radar,

nicknamed Token, 'had no capability above 60,000ft'. Token coverage was supplemented by two metric (VHF-band) air defence radars, P-3 and P-8, code named "Dumbo" and "Knife Rest", respectively, and believed to have similar capabilities. The NIE was correct as far as the P-3 and P-8 were concerned, since these could only provide bearing and range information.

However, the West knew nothing about the A-100 radar, which provided early warning for the SA-1 "Guild" (Soviet designation S-25) surface-to-air missile (SAM) systems located around Moscow. The SA-1 was a first-generation air defence system, employing the E-band radars for target acquisition and fire control and missile command guidance. It was very short-lived, and soon replaced by the far more capable SA-2 "Guideline" (S-75 Dvina). Alarmingly, the NIE estimate of Token's capability was soon proved wrong.

The list of Soviet targets for the U-2's camera package was by now huge, so much so that Bissell established a system of prioritizing them by organizing the Ad-hoc Requirements Committee (ARC). A CIA staff officer chaired the committee and it was drawn up from representatives of the three main armed services. The top priority targets were passed to Project HQ, where mission planners devised potential routes for U-2 flights. They knew that they had to cram as many targets as possible into each mission. Having read the detailed brief on Project Aquatone, Eisenhower told his staff secretary, General Andrew Goodpaster, that he wanted all the vital targets covered as quickly as possible. The president also made it clear that he wanted the flights stopped if they could be tracked, as he was acutely aware of the political sensitivities.

In anticipation of Eisenhower's decision, two U-2s had been air freighted to RAF Lakenheath, England, on 30 April 1956, where the first of three Agency detachments was formed under the entirely fictitious designation 1st Weather Reconnaissance Squadron, Provisional (WRSP-1). Within the 'inner circle' this was known as 'Detachment A' and consisted of Agency and Air Force personnel, and contracted civilians. However, on 16 May Prime Minister Anthony Eden wrote to President Eisenhower requesting a postponement of Det A's operations, following an embarrassing incident with the Soviet Union over an attempt by Royal Navy frogmen to covertly survey the cruiser *Ordzhonikdze* in Portsmouth harbour while it was carrying Nikita Khrushchev. No operational sorties were therefore flown from the UK and the unit redeployed to Wiesbaden, West Germany on 15 June. This new location was close to Camp King, the Agency's main West German intelligence-gathering facility.

On 20 June 1956, the first U-2 operational mission took place when Carl Overstreet departed Wiesbaden on Mission 2003. Using the A-2 camera system – the B became available later in the year – Overstreet flew over areas of East Germany, Czechoslovakia and Poland before recovering safely back at Det A. The undeveloped film and SIGINT tapes were unloaded and flown back to the US, where they were processed and examined two days later.

On 2 July two U-2s left Wiesbaden in rapid succession. Mission 2009 flew south, covering Hungary and Bulgaria to the Black Sea, while Mission 2010 covered eastern Czechoslovakia, Hungary and into Romania, also reaching the Black Sea before turning back. Both aircraft safely landed back at Wiesbaden.

On 21 June, Bissell, Killian and Land travelled to the White House, where Goodpaster explained the president's thinking. Eisenhower was going to keep tight control of the flights, wanted frequent reports and, despite the CIA's assurances, remained worried that the flights might be detected. As decision time to launch the U-2 on Soviet overflights loomed ever closer, Eisenhower's anxiety grew, and on 2 July he told Goodpaster that he urgently needed to know whether the missions launched to overfly targets in the Soviet satellite countries had been picked up.

On 3 July 1956, before the post-flight analysis of the first three missions was complete, Eisenhower had Goodpaster tell Bissell that he'd approved a 10-day slot for Soviet overflight

missions, but that he was to be provided with interim reports on tracking and attempted interception.

No time was wasted, and since Wiesbaden was six hours ahead of Washington, it was 06:00hrs on US Independence Day, 4 July, when Hervey Stockman took off on Mission 2013. He covered targets around Minsk and Leningrad, but peering through the aircraft's drift-sight he saw MiG fighters climbing in an attempt to intercept. Contrary to all American hopes, the flight had been detected. Undeterred, Stockman continued his mission as planned, passing over suspected Soviet bomber bases in the Baltic States before recovering into Wiesbaden following a flight lasting eight hours 45 minutes.

Following the successful completion of that first mission, Eisenhower had Goodpaster tell Dulles 'if we obtain any information or warning that any of the flights has been discovered or tracked, the operation should be suspended until he (the president) has an opportunity to consult on the matter with Secretary [of State John Foster] Dulles and Allen Dulles'. After being told this, Allen Dulles and Bissell went to the White House to clarify the message. They told Goodpaster that it would be at least 36 hours after each mission before they would receive the first reports of detection, tracking and attempted interception, and that it could be as long as several days or weeks. If they had to wait this long between each mission, they would not be able to follow the president's intention of covering as many targets as quickly as possible. Goodpaster told them that he understood that the president wanted the mission to 'go forward at the maximum rate until the first evidence of tracking was received'.

On 5 July 1956, Article 347 was again airborne, this time with Carmen Vito at the controls, on U-2 Mission 2014, an overflight that encompassed the Soviet capital, Moscow. Again the U-2 was detected. MiGs were sent to intercept the aircraft but were unsuccessful.

Eisenhower was informed that the flights were being detected, though still imperfectly. Despite considering halting Aquatone, the president decided it could continue until more definitive information was available.

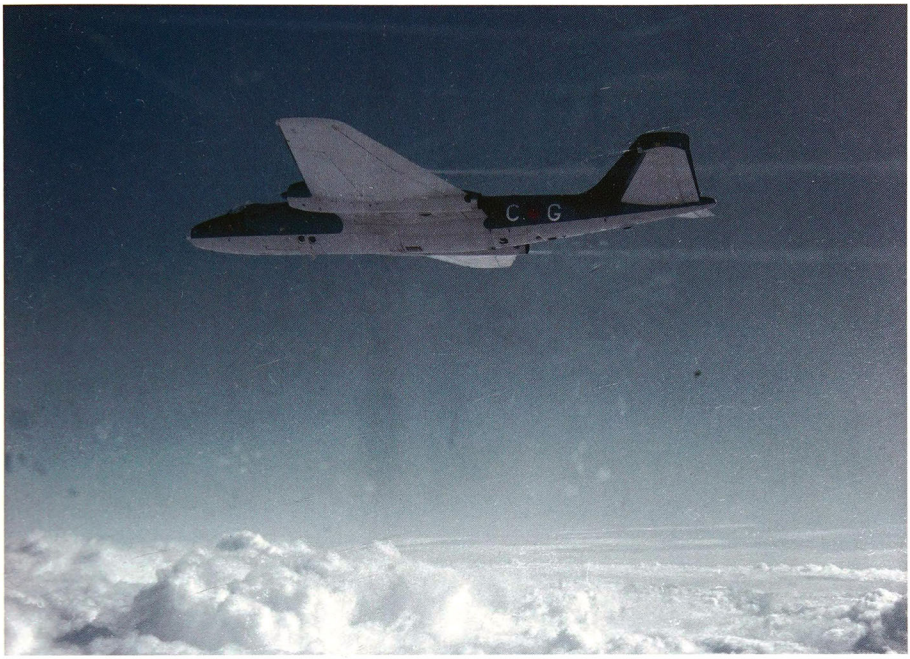
Back at Wiesbaden, bad weather had prevented further overflights and it wasn't until 9 July that two U-2s got airborne in quick succession. Marty Knutson flew Mission 2020 up the Baltic coast to Riga before turning to cover targets around Kaunas, Vilnius and Minsk, then returning to Det A via Warsaw. Meanwhile, Carl Overstreet took Mission 2021 over the Ukraine as far as Kiev before returning to 'home plate' via southern Poland. While Overstreet was transiting Kiev, anti-aircraft artillery (AAA) put up a spirited but futile show of defiance that attracted plenty of attention, especially from Kiev's residents.

Next day, Glen Dunaway flew Mission 2024 all the way to Kerch on the eastern tip of the Crimea peninsula, returning via Sevastopol, Simferopol, Odessa and the satellite countries. Apart from what were fast becoming the usual attempted fighter intercepts far below, this fifth U-2 overflight mission was without incident.

Early on 10 July 1956, Goodpaster informed Eisenhower about the meeting he'd had with Dulles and Bissell a few days earlier, adding that there had been some indications of tracking. The president wasn't impressed and according to Goodpaster he seemed very close to stopping the overflights.

By now the Soviet 'diplomatic cage' had been well and truly rattled. Later that same day the USSR delivered a protest note about the previous days' flights to the US embassy in Moscow. It was clear that the Soviet air defence system had not only detected each flight, but had tracked them for considerable distances. After this was communicated to Eisenhower, as far as he was concerned the game was up: he believed that detection was almost as bad as interception and immediately suspended all U-2 overflights.

The president was extremely annoyed that assurances given by Bissell and others had proved false – they'd told him that the flights would hardly be detected, let alone tracked.



Eisenhower never again gave the CIA *carte blanche* for a series of U-2 overflights. When he eventually authorized it to continue, it was on the basis of one clearance, one flight and he wanted to know all the details regarding routes, defences, etc. More often than not, he withheld permission.

▲ The RAF used variants of its Canberra medium bomber in the PHOTINT/ELINT role. the types was also built under licence by Martin, the USAF employing it as the B-57, EB-57, and RB-57. First flown on 13 May 1949, the highly successful Canberra remained in service with the RAF until 2006, when the finished PR.Mk 9s stood down. This PR.Mk 7 was photographed on 12 July 1984, contrailing at altitude with the protective doors of its camera windows retracted. (Paul F.Crickmore)

CHAPTER 2

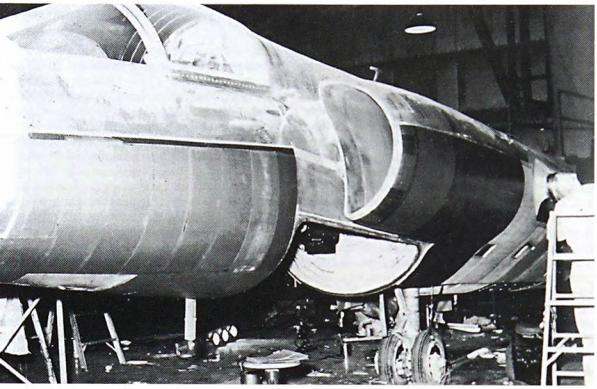
RAINBOW AND GUSTO

On 16 August 1956, Richard Bissell convened a meeting to explore initiatives that could be developed into solutions regarding the problem of the U-2 being detected by radar and thereby address Eisenhower's concerns. Kelly Johnson later wrote:

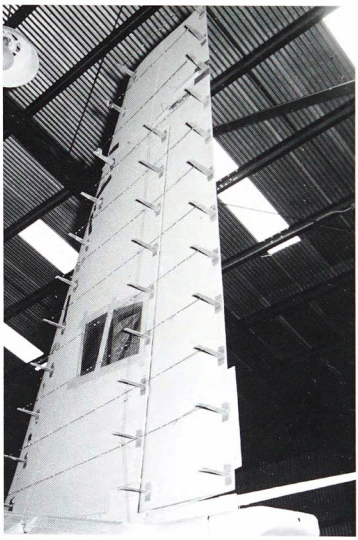
> Up to see Land, Purcell, Stew Miller with Herb and Dick [Herb Miller and Dick Bissell]. Worked till 1:30 and two bottles of Scotch. Up at 7:00 and we resumed – even Dick. By noon we had program 'X' going. My biggest job now.

By midday, they'd devised a programme that would explore various radar-cancelling devices and the project was accorded the classified cryptonym Rainbow. It was the first attempt to make an operational aircraft 'stealthy'. Land chaired the project and a small number of radar experts were recruited into the programme via Marshall Holloway, Director of the MIT Lincoln Laboratory, in Lexington, Massachusetts. Based in a secure building on the roof of the Lincoln lab (often referred to as the RadLab), it included Dr Frank Rodgers (associate head of the Radar Division).

◀ Model of the subsonic Gusto 2A. (Lockheed Martin)



▲ A U-2 having radar-absorbent material (Echosorb) applied to its lower fuselage. (Lockheed Martin)



▶ In an attempt to hide the U-2 from Soviet radars operating in the metric (VHF) wavebands, wires were positioned at carefully measured distances on the aircraft's wings, fuselage and tail surfaces. (Lockheed Martin)

A major problem facing the team was the broad band of frequencies that a U-2 would encounter during the course of a Soviet overflight. First it would need to remain invisible to long-range, low-frequency early warning radars operating within the V-band (65–86MHz). Then, having penetrated Soviet airspace, it would have to contend with high-frequency S-band (2–4GHz) and X-band (8–12GHz) target acquisition radars. Since a single broad-band solution (one that would counter all the frequencies) wasn't technically feasible, methods and materials would need to be developed to defeat the different radar systems.

To deceive S-band radars, the team came up with a radar absorbent material (RAM) treatment they called 'Wallpaper', which was applied to the underside of the aircraft's fuselage. It was a clever implementation of a Salisbury screen, working on the quarter wavelength principle. Just ¼in. thick and weighing 1oz/sqft, it consisted, from the inside out, of fibreglass, a honeycomb spacer, a graphite-impregnated layer, a protective layer for durability and a layer of paint.

The graphite-impregnated layer was key, because its electronic properties caused it to behave as though it were much thicker. This meant that even though the coating was 1/16 of a wavelength in thickness, it acted as though it was quarter of a wavelength. With the graphite layer effectively positioned a quarter of a wavelength from the aircraft's skin, it would reflect some of the incoming radar energy. The remaining energy would strike the U-2's actual surface and then be reflected, these 'emergent waves' cancelling out the graphite-reflected waves since they were 180° out of phase. It was also found that by cutting a small iris into the centre of each square of 'Wallpaper' it would also and reduce returns from X-band radars.

The greatest difficulty facing the Rainbow team was how to defeat the Soviets' early warning V-band radars with their 14ft wavelength. The RadLab, in conjunction with a small team of electronics engineers back at the Skunk Works, headed up by Luther Duncan 'LD' MacDonald and including Perry Reedy and physicist Ed Lovick, eventually developed two systems referred to as 'Trapeze' and 'Wires'.

Trapeze featured copper-plated steel wires strung spanwise around the leading and trailing edges of the wings and tailplanes. Fibreglass wing and tailplane tip extensions supported the

wires, as did intermediate chordwise fibreglass 'fishing poles'. To adjust the impedance of the wires to form a slow wave structure, ferrite beads were strung on them at precise locations. Chordwise wires connected the spanwise wires to the wing leading and trailing edges, and ferrite beads were again to tune the frequency response. Trapeze formed a slow wave structure, which induced currents that suppressed the rhombic lobes otherwise generated by the U-2's wing and tail planform.

The sides of the U-2's fuselage generated a large reflection at some frequencies. To counter this, the team jointly developed Wires, a similar Heath Robinson contraption to Trapeze. A form of Salisbury screen was created by placing groups of ferrite beads at regular distances along long wires running along the fuselage, and across the tail fin. Each long wire behaved as though it were a series of separate wires, or dipoles, counteracting the radar signal.

With two U-2s dedicated to project Rainbow up at Watertown, flight tests against radars on the Indian Springs AFB range provided mixed results. Trapeze reduced 70MHz returns by 20dB and S-band returns by about 10dB. Overall the U-2's radar cross section (RCS) was reduced to a point that halved its detection range – in other words, the return from a treated aircraft (referred to as Dirty Birds by the Skunk Works engineers that worked on them and Covered Wagons by the operational pilots) was the same as an untreated aircraft located twice as far from the radar head. But the problem with these modifications were that they added weight and drag to the U-2, reducing its maximum range by about 20 per cent and its altitude by 5,000ft, and none of the operational pilots relished the prospect of being closer to Soviet fighters.

On 6 May 1957, Bissell and Dulles briefed Eisenhower on Aquatone and the expected results of Rainbow. Bissell believed that the majority of treated U-2s undertaking Soviet overflights now stood a good chance of avoiding detection entirely, and in the proportion that were detected, their continuous tracking would be extremely difficult, as would interception, even after the Soviets had developed aircraft or missiles capable of reaching the U-2's altitude. On the basis of such a positive briefing, preliminary approval was granted for more Soviet overflights, despite the fact that phase one of Project Rainbow hadn't yet been completed.

In June one Dirty Bird was deployed to each of the U-2's three OLs. Two penetration flights of the Soviet Union were made from Turkey on 21 and 30 July 1957 to evaluate the effectiveness of the treatment. Despite Trapeze, Wires and Wallpaper, analysis of the aircraft's System 5 (a multi-band radar recorder) revealed that Soviet radars had been alerted to its presence it was flying directly towards or directly away from the radar head. This led to the conclusion that radar returns had emanated from the U-2's inlets, cockpit and exhaust, none of which could be treated by the systems developed thus far. Clearly a far more radical approach to the problem was required.

Bissell knew that this next stage of the project would be both hi-tech and high risk. It was essential that the US government was kept appraised of progress without compromising project security. Therefore on 19 November 1957, he wrote a memo to Deputy Secretary of Defence Donald Quarles, in which he outlined progress to date and his overall plan for the project's next step. He emphasized that the bulk of governmental expertise in radar research lay within the Air Force and Navy, not the CIA, and that 'the most intimate cooperation' would be needed. He noted that the three services would try to limit discussions with manufacturers and avoid issuing formal requirements that could stimulate unusual interest in the concept of a 'radar invisible' aircraft. Once an acceptable design had been developed, a crash programme would produce eight to 12 aircraft. Finally, Bissell recommended that the response to any questions from the Foreign Intelligence Board should avoid any description of the concept, simply stating that a system was being studied with great urgency, that funding and management were under control, and that if the system proved feasible there would be a recommendation for action.

To assist him in evaluating the proposals, Bissell once again called upon the services of Edwin Land to serve as chairman of an advisory panel. Taking its chairman's name, members of the Land Panel (some of whom had served on the Beacon Hill study group) varied slightly over the coming months, but when they first met in November 1957 the panel consisted of Ed Purcell, Allen Donovan, Bissell's assistant Eugene Kiefer, H. Guyford Stever (head of the engineering department at MIT), and the Air Force's chief scientist, Courtland Perkins.

Between July 1958 and the late summer of 1959 the committee would meet on six further occasions to discuss, evaluate and recommend the various designs. The meetings usually took place in Land's Boston office and almost always included the Air Force's Assistant Secretary for Research and Development, Dr Joseph Charyk, and his Navy counterpart, Assistant Secretary of the Navy (Air) Garrison Norton, as well as various designers from several aircraft manufacturers.

Frank Rodgers at the Lincoln lab was certainly up for a radical approach to the RCS challenge. He returned to basic research in a bid to understand the relationship between a radar return and the physical shape of the target without regard to the aerodynamic practicality of such shapes. To his surprise he discovered that if a metal saucer shape were treated by layering circular sheets of Teledeltos paper (a paper with a constant resistance) on top of the shape, with the first sheet of greatest diameter and each successive sheet being smaller, by the time the sixth sheet was positioned, resistance was down to 300Ω (ohms) – the same as in the free space through which the radar wave was moving. This prevented reflections completely, effectively rendering the shape invisible to radar.

Rodgers had produced a broad-band treatment that was effective against any radar operating at any frequency within a very broad range. This was in contrast to the 'narrow-band' techniques developed and applied to the Dirty Birds, whereby if a radar were encountered operating at a frequency different from that which the treatment had been designed to defeat, its effectiveness was significantly reduced. Unfortunately, the shape of the vehicle was aerodynamically unstable, but Bissell was extremely impressed and Rodgers and Norm Taylor were instructed to present the findings to Johnson. Rodgers began to explain that that the ideal shape for a stealthy aircraft was a flying saucer, to which Kelly replied, 'For Christ's sake!' adding that he couldn't make a real aircraft that shape, and that clearly Rodgers knew nothing about aerodynamics. To which an equally headstrong Rodgers retorted that Johnson obviously knew nothing about radar. That was the end of the meeting!

After later analyzing the discussion, Rodgers and Taylor decided that it wasn't the idea that had been wrong, but their presentation. In future they wisely decided that they'd leave the final design of the aircraft to Johnson and instead feed him RCS guidelines that he could incorporate into his design.

Back at the Lincoln lab, concern was being expressed in some influential circles that work being conducted by Rainbow for the CIA was inappropriate. So in October 1957 it was moved out to a building in Cambridge, Massachusetts, where it was incorporated into the Scientific Engineering Institute (SEI), a Boston-based CIA proprietary. The move also prompted changes within the team, although Frank Rodgers stayed.

Johnson of course had his own team of electronic engineers working on the problem back at the Skunk Works. Ed Lovick recalls:

> Kelly thought that an aircraft made of plastic materials might have sufficiently small low-frequency radar backscatter to defeat the 70MHz early warning radars. I warned him that it would not and that you'd see the internal structure, the square corners it formed and the fuel.

But Kelly wanted to test it anyway. Despite the fact that it was known that practical fibreglass structure would be dense enough to scatter 4in. S-band radar waves, he still hoped that an all-plastic airframe might not backscatter 14ft wavelengths significantly. The engine, landing gear and any other metallic items were to be hidden by an, at that time, unspecified means. Several all-fibreglass models that incorporated appropriate internal plastic structures were built and tested. One model was to ⅛ scale and too large for indoor testing, so it was tested at Indian Springs AFB.

Backscattering measurements showed that the thick plastic sections required for strength, and especially corners, were very reflective. When kerosene fuel was added to the interior of the wings, the reflections increased and became characteristic of a solid piece of plastic. When the fuel in partially filled tanks was vibrated and standing waves occurred, the backscatter increased even more.

After attempts to hide the structure, fuel and simulated engines yielded poor results, Kelly agreed to abandon the idea.

More gloomy news followed in January 1958, when two intelligence assessments of Soviet interception capabilities had been compiled. They indicated that the only areas where the U-2 could fly without certain detection were central Siberia and to the east of Tashkent towards China. Two new types of radar had been detected and, in addition, it was considered likely that limited numbers of a specially designed fighter having the ability to operate above 70,000ft would soon be available. SAMs were also expected to become a serious threat to Aquatone from 1959 onwards. The pressure was now on to rapidly develop and deploy a stealthy U-2 replacement.

January 1958 saw the Agency assign the classified cryptonym Gusto to phase two of Rainbow, and at the end of the month Kelly Johnson wrote to Bissell proposing a four-point work statement for Gusto, which was approved on 11 February. However, since it remained possible for Soviet radar operators to continue to locate and track U-2s equipped with the anti-radar systems that had thus far been developed, the CIA cancelled Project Rainbow in May 1958. It was also at about this time that Lockheed built its first anechoic chamber in which to measure the RCS of various design models.

Johnson and some of the key members of his team, including Dick Boehme, Ed Baldwin and Harry Combs, now began working on a number of high-risk, subsonic designs with low RCS their top priority. They'd formulate a shape with minimum RCS values and then work on ways to make it fly within the specified performance envelope. This series of designs was known to the Agency as Gusto Model 2, and over the following months Lockheed studied numerous design permutations under this overarching code name.

One rejected design had notches cut into the leading and trailing edges of its wings, into which were inserted triangular wedges of graded dielectric material. This technique, called 'edge softening', avoided generating an abrupt change in resistance of the incoming radar beam when it first met the aircraft (it is these abrupt changes that generate reflections). Using this technique, when the incident beam strikes the baseline of the triangle (located at the outer edge of the aircraft), it is reflected inside the wedge, generating electrical currents that turn the radio wave's electromagnetic energy into heat. The resistance progressively reduces to zero by the time the energy reaches the tip of the triangular wedge, at which point it matches that of the adjacent metal structure. Invented by Ed Lovick, the technique would play an important role in reducing the RCS of Johnson's ultimate design.

SUNTAN

In addition to working on projects Aquatone, Rainbow and Gusto for the CIA, Kelly Johnson also began working on an Air Force project. Mindful that the U-2's ability to safely execute deep penetration missions, particularly over the Soviet Union, would inevitably be time limited as a result of expected advances in anti-aircraft technology, Air Force analysts at Wright Field had embarked upon a series of studies into U-2 replacement options even before the type's first flight.

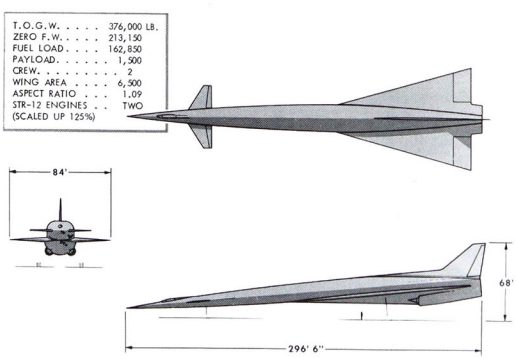
Despite various post-war studies in the United States proving that liquid hydrogen was a viable, albeit volatile fuel for rockets and aircraft, nothing in the way of concept flight testing had been undertaken. However, on 24 March 1954, a British engineer named Randolph Rae personally delivered to the Air Force's new development offices at Wright Field a proposal outlining the development of a unique liquid hydrogen-fuelled aircraft. Propeller-driven, the design was optimized to cruise at an altitude in excess of 75,000ft and cruise at a speed of about 500mph. Although these performance figures were in themselves outstanding, it was the Rex I engine that particularly interested the Air Force engineers.

Randolph Rae was formally associated with the Summers Gyroscope Company, but during the subsequent review process of his drawings and calculations at Wright Field, the company was quietly acquired by the Garrett Corporation specifically to gain access to the engine patent. The ensuing, protracted litigation continued to follow the Rex I throughout its life.

The Skunk Works became involved in the project in mid-1954 when, under the original proposal, it was agreed that it would be provided with $50,000 to conduct an airframe analysis. However, ongoing legal problems over the patent issue delayed contract ratification between Rae and the Garrett Corporation until October 1955. All seemed on track until the Air Force issued its work statement a few weeks later; it called for a high-altitude supersonic design, the range of which was of secondary importance.

Not wishing to forego Air Force funding allocated for the Rex engine – one of the three designs now available was for a supersonic cruise aircraft – Garrett decided to pursue an airframe study that had earlier been given to Rae and since the Skunk Works had been involved in the initial airframe negotiations in 1954, it was invited to provide airframe input. However, after reviewing Garrett's data, the Skunk Works engineering team concluded that the proposed engines would be incapable of producing the thrust required to meet the Air Force performance specification. Further calculations indicated that they engines need to be 50 per cent more powerful if the desired cruise speed of Mach 2.25 was to be achieved. This forced the Air Force to evaluate Garrett's ability to build such an engine.

▼ Project Suntan's CL-400 design provided Johnson with important insights into possible fuels for the U-2 replacement. (Lockheed Martin)



On 15 February 1956, two Skunk Works design proposals, designated CL-325-1 and CL-325-2 and powered by the supersonic Rex III liquid hydrogen engine, were presented to the Air Force at Wright Field. However, after extensive studies the Air Force became convinced that Garrett was incapable of building an engine as complex as that proposed and on 18 October 1956 it issued a directive demanding that all work on both projects be stopped, except for the completion of a final summary report.

Impressed by the notion of a hydrogen-fuelled aircraft and encouraged by the Air Force to develop a U-2 follow-on, Kelly Johnson and his Skunk Works' team had begun their own studies into the concept a year before cancellation of the Rex III design submissions. During a Pentagon meeting with Lt Gen Donald Putt, head of ARDC, in early January 1956 Kelly offered to build two prototype hydrogen-fuelled aircraft powered by more conventional engines and have them delivered within 18 months of contract signing. Based upon the CL-325, they would be capable of cruising at an altitude of over 99,000ft at a speed of Mach 2.5 and have a range of 2,500 miles.

With the Air Force suitably impressed, a second meeting was held at the Pentagon on 18 January, during which it was decided to fund studies to verify Kelly's proposal and select a qualified manufacturer to design and build a hydrogen-fuelled engine. By the end of February, proposals from Pratt & Whitney and General Electric had been reviewed and on 1 May 1956 a six-month study contract was signed with Pratt & Whitney for the engine and the Skunk Works, to evaluate airframe configuration and material options. Air Force programme management was headed by Lt Col John Seaberg, assisted by Maj Alfred Gardner (engine development) and Capt Jay Brill (logistics). As the aircraft's mission would be the penetration of denied territory, just 25 people were cleared into this special-access-required programme, code named Suntan.

In 1956, the Skunk Works signed a contract to produce four production aircraft for the Air Force, in addition to the two prototypes and a single static test specimen; the design was now designated CL-400.

Having joined the Skunk Works in 1954 as an entry-level engineer specializing in thermodynamics, Ben Rich became a key member of the Suntan project and was involved in the feasibility studies that would prove liquid hydrogen was safe and practical to produce in large batches. To produce the highly volatile fuel, a production facility was established in a remote corner of the Lockheed complex at Burbank airport that had served in World War II as a communal air raid shelter for workers from a nearby B-17 Flying Fortress factory. As Ben later noted, 'It had 8ft thick walls and underground bunkers and was located about as far away from the rest of the Skunk Works as it could be, in case something went wrong and we blew up!'

Ben and 13 Skunk Works personnel set to work. In less than three months they were producing more than 200 US gals of liquid hydrogen per day, within the walled compound that had become known as Fort Robertson after project worker Dave Robertson. Despite the temperamental nature of the fuel, not a single accident occurred and visitors cleared into the project for site tours were often given Martini icicles; the gin and vermouth mixture was poured into a Dixie cup, a lollypop stick inserted and the complete ensemble then immersed in liquid hydrogen; the result was a frozen Martini on a stick!

On 18 August 1957, Pratt & Whitney had completed its first Model 304 engine. It was transported from the facility at East Hartford, Connecticut, to P&W's new plant at West Palm Beach, Florida. On 11 September static tests were initiated, using nitrogen to check the engine's rotating elements and fuel system. During October the first runs took place, followed by a second series in December after engine inspection. A second engine began tests on 16 January 1958, and an improved motor, designated Model 304-2, was delivered and tested for the first time on 24 June. The trials went extremely well, Pratt & Whitney and the Air Force gaining considerable confidence in the hydrogen-fuelled units.

All seemed to be running according to schedule. The Air Force had allocated $95 million to Suntan, Kelly had ordered no less than 2½ miles of aluminium extrusion for airframe production, the 304 engine continued to perform as planned, the Air Products company was constructing a large hydrogen liquefaction plant in Florida, and MIT was working on an inertial guidance system.

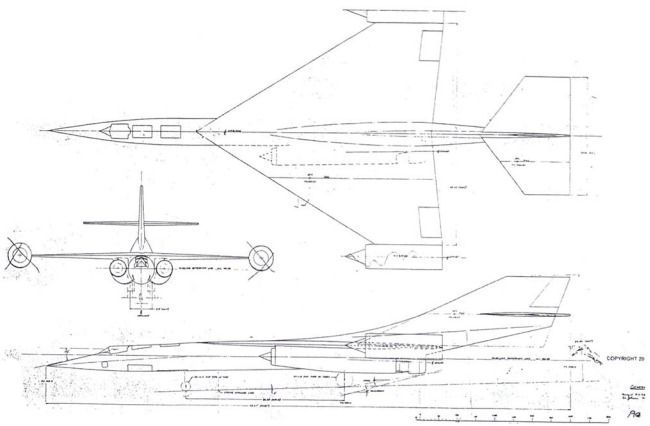
But over the next six months something continued to bother Kelly. Despite having successfully sold the aircraft to the Air Force, it was becoming increasingly apparent to him that the CL-400's severe range limitations couldn't be designed out. The design fell short of its estimated original lift-over-drag ratio by 16 per cent, while stretching the fuselage to increase fuel capacity by way of compensation would result in only a 3 per cent increase in range. Meanwhile, Pratt & Whitney estimated that no better than a 5–6 per cent improvement in specific fuel consumption (SFC) could be achieved with its Model 304 engine over a five-year period of operation. Such low growth potential, coupled with the logistical problems associated with pre-positioning liquid hydrogen to forward operating locations, convinced Kelly that 'the aircraft was a dog'. In March 1957, during a meeting with James Douglas Jr, then Secretary of the Air Force, and Lt Gen Clarence Irvine, Deputy Chief of Staff for Materiel, Kelly bluntly informed them of his misgivings.

A meeting of the Land Panel between 22 and 23 September 1958 finally resolved any lingering misgivings when it voted to terminate Suntan. The Skunk Works returned almost $90 million and the opportunity for the Air Force to wrestle back the strategic overflight programme from the CIA slipped from its grasp.

On a positive note, however, Project Suntan had provided Lockheed with an improved understanding of high-speed flight as well as confirmation that hydrocarbon fuel and not hydrogen was the best choice for the proposed flight regime, since hydrogen was so difficult to handle. It also provided Kelly with a major change in direction for Project Gusto.

SUPERSONIC GUSTO

The dichotomy for Kelly Johnson was the seemingly inverse relationship between 'stealth' and performance, which would be a recurring theme throughout his design submissions for a U-2 replacement. A conventional design was most likely to deliver the required performance, but often proved too easily detected by radar, whereas a design emphasizing stealth struggled to deliver the prerequisite performance. Johnson was also concerned by the speed of Soviet radar development which, coupled with the inevitable use of more diverse radar frequencies would, he was convinced, further complicate the search for a panacea to these conflicting paradigms. Therefore on 21 April 1958, probably as a hedge against these problems, Johnson began sketching his first Mach 3 design for the Agency, which put extreme speed and altitude



▶ Archangel 1 (Lockheed Martin)

performance at the heart of vehicle 'survivability' rather than stealth.

He named the design in his notebook 'U-3'. 'I drew up the first Archangel proposal for a Mach 3.0-cruise airplane having a 4,000nm range at 90,000 to 95,000ft.' (This notebook would subsequently become known as his 'Archangel' notebook: Skunk Works insiders often referred to the high-flying U-2 as 'Kelly's Angel', and since this new design represented another performance leap, 'Archangel' seemed a logical extension).

To power the ADP design, two engine types were examined, the Pratt & Whitney J58 and General Electric J93. By June, studies concluded that the former would provide superior performance. Over a number of days, Johnson continued to refine and further investigate the high-speed design before reporting his findings to Bissell.

Under Frank Rodgers, a team from the SEI conducted a blip-scan analysis of Johnson's U-3 proposal. Taking into account the design's speed, altitude and RCS they were able to evaluate the dwell time in which the aircraft would remain within a radar beam, and therefore its probability of detection. Three frequencies, 70, 600 and 3,000 megacycles per second, were considered in these computations, and the subsequent report was highly significant, becoming known as the 'Blip-Scan Study' and also the 'Rodgers Effect'. It identified specific design targets that became enshrined in the programme, namely a speed of Mach 3, an altitude of 90,000ft, and an RCS of not more than 10m2 square metres and preferably less than five.

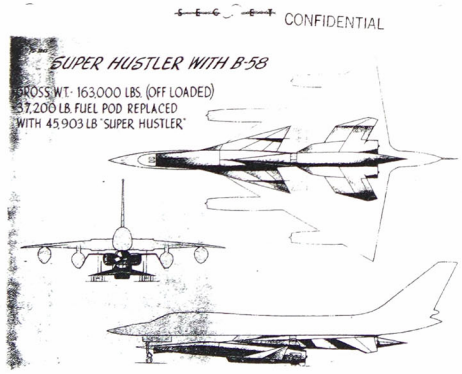
THE COMPETITOR

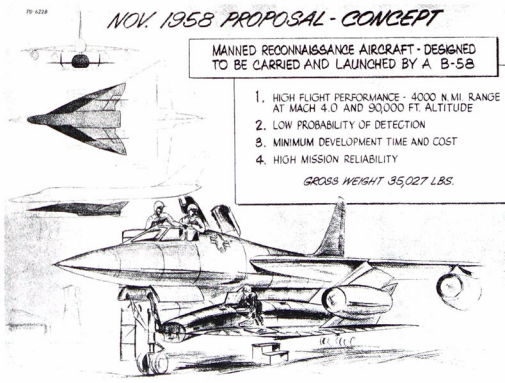
In the spring of 1958, Bissell flew to Fort Worth, Texas, where he met Robert H. Widmer, head of advanced development at the Convair Division of General Dynamics. Bissell told Widmer that he required a reconnaissance aircraft capable of flying undetected at 90,000ft, with a 4,000-mile range and 2,000lb payload. As he had with Lockheed, Bissell kept his initial requirements simple and without a written specification. Bissell stated in his memoirs that he brought Convair into the project on a point of due diligence and also to assuage any criticism when it came time to possibly awarding a multi-million dollar contract.

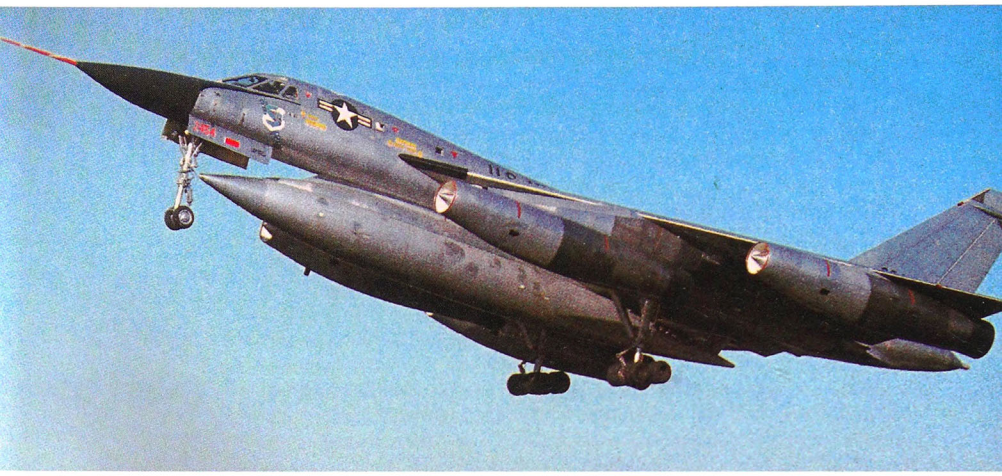
However, others on the inside track have gone on record as saying it was done because Johnson was more concerned about taking an aerodynamic quantum leap than minimizing the RCS of a U-2 successor (the latter being something that President Eisenhower himself had

◀ Convair used its Super Hustler design as the basis for entry into Project Gusto. (Convair)

▼ Convair's First Invisible Super Hustler (FISH) was a radical design, combining extreme speed and altitude with a very small RCS. (Convair)







▲ An order from SAC for a stretched version of Bob Widmer's B-58A – shown here – equipped with uprated engines, was an essential element of Convair's FISH proposal. (Convair)

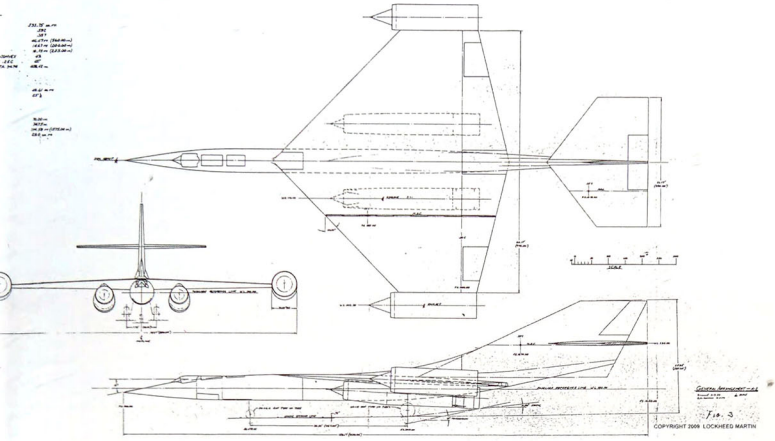
insisted upon). Therefore this precipitous action also provided Bissell with leverage to use against Johnson when he thought the Skunk Works boss was not focusing enough on RCS design issues.

Convair's first proposal in the competition was based upon a radical variation of a design called Super Hustler. This nuclear bomber would have used a modified B-58 bomber to carry aloft a two-stage parasite aircraft, the aft section of which would later be jettisoned to increase overall range. The front, manned section carrying the weapon was to have been powered by ramjets for cruising and a turbojet for landing. The proposed reconnaissance variant required a number of significant changes, not least because jettisoning sections of an aircraft over hostile territory was hardly covert! In addition, Super Hustler was not stealthy. So a team of seven principal design engineers, under Donald R. Kirk, began working on what they referred to as the First Invisible Super Hustler or FISH.

Consisting of only the front section of the Super Hustler design, crew numbers for FISH were reduced from two to one. Its offset, pressurized cockpit escape capsule (a feature that would later be incorporated into General Dynamic's F-111 design) meant the pilot didn't require a full pressure suit (unlike the Lockheed designs), which greatly reduced crew fatigue. To provide the pilot with an external view of the outside world when in flight, two TV cameras were mounted in the nose.

FISH would be powered by two Marquardt ramjet engines burning high-energy fuel (HEF). To achieve the necessary ramjet start speed, the small parasite vehicle would be launched from a specially modified B-58B flying in excess of 35,000ft at Mach 2.2. FISH would then accelerate to Mach 4.2, cruise at 90,000ft and have a range of 3,900 miles. Having completed its mission, it would decelerate and two Pratt & Whitney JT12 turbojets would be extended from the upper fuselage to power the aircraft back to base.

To reduce its RCS, the designers changed both the leading and trailing edges of the wing from straight lines to arcs of circles. To withstand thermodynamic heating caused by flying at such high speeds, the steel honeycomb wings incorporated wedge-shaped Pyroceram inserts on both the leading and trailing edges. A ceramic material, Pyroceram was also impregnated with graphite to absorb incident radar energy, thereby reducing the vehicle's RCS. The project was code named Idiom by Bissell's office, and on 22 June 1958 the work was formally moved into Gusto.



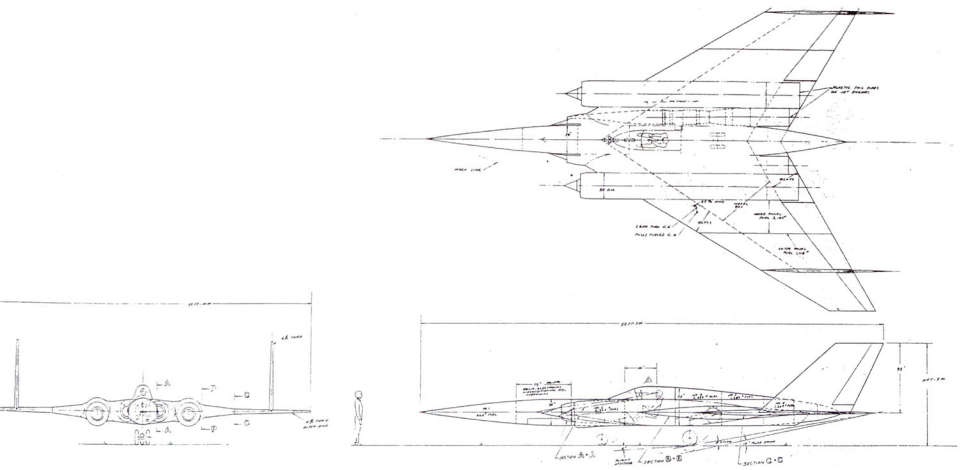
◀ Archangel 2. (Lockheed Martin)

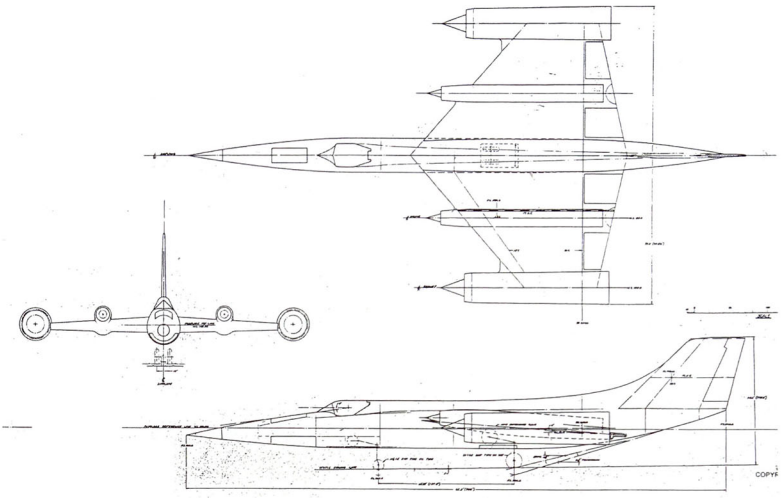
On 23 July 1958, Johnson attended a meeting at Land's Cambridge office and presented Archangel and Gusto 2A. He noted in his log that both designs were 'well received'. A Navy commander also present alluded to a Navy idea for an inflatable aircraft and Bissell requested Kelly's comments on the concept.

A week later, on 31 July, the advisory panel met to formally discuss both Lockheed concepts, during which Bissell noted that reasonable progress was being made, but that he thought the way forward would become clearer after the September advisory panel meeting.

Provided with details about the intriguing Navy concept, Kelly conducted a thorough evaluation for Bissell. Under the Navy project name Champion, Goodyear was proposing a reconnaissance vehicle with inflatable wings that could be rolled up while in transit aboard an aircraft carrier and inflated for launch. It was envisaged that the ramjet-powered vehicle would be lifted to altitude by balloon and cruise at between 125,000 and 150,000ft. A quick

▼ Archangel 3. (Lockheed Martin)





▶ Design iteration of Archangel 3. (Lockheed Martin)

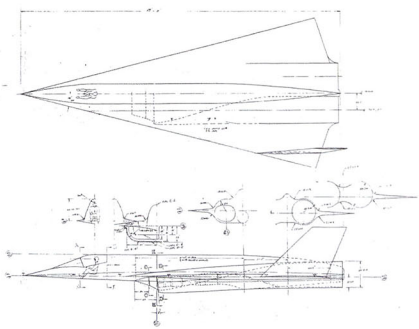
calculation by Johnson determined that the balloon would need to be more than 1 mile in diameter! A more detailed study followed in which a tug aircraft was also evaluated, but the unreliability of the concept for reconnaissance over highly sensitive areas was enough to ensure that it didn't progress.

On 25 August 1958, Johnson noted in his log:

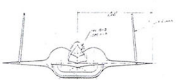
> Have contacted Marquardt and P&W, and gotten some ramjet data. Have reconfigured the Archangel to include wing tip ramjets, as per our proposal on the F-104 to the Air Force in 1954. This appears to give us an airplane which would cruise at Mach 3.2 at 95,000 to 110,000ft for the full distance.

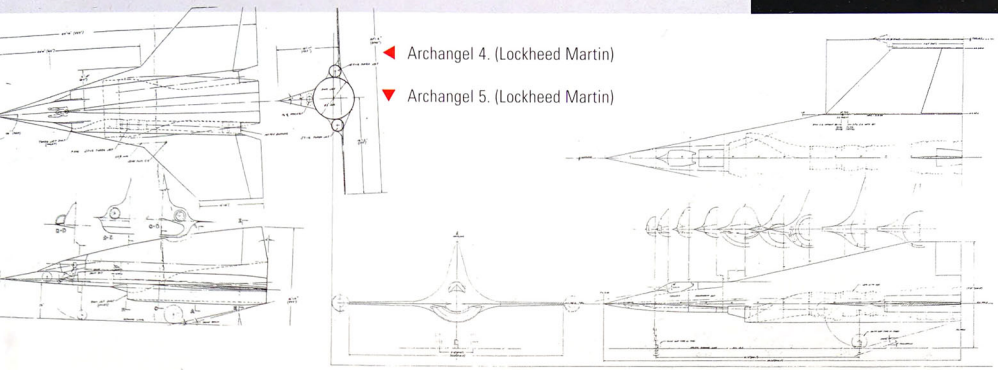
However, Archangel 2 made no concessions to reducing RCS.

The Land Panel convened in Boston between 22 and 23 September and Johnson and Widmer presented their designs independently. The panel consisted of Bissell and Kiefer, Din Land, Ed Purcell, Frank Rodgers and Guyford Stever. From the Air Force were Gen Swofford, Cols Norman Appold and John Seaberg, Maj Bob Hippert, US Navy Admiral Struble and Dick Horner. The panel decided to terminate further studies into Champion and Suntan and voiced interest in the Convair design, but rejected Archangel 2 primarily on the grounds of its poor RCS. Gusto 2A, the board contended, required further development. Kelly noted, 'We left Cambridge rather discouraged with everything'.



▼ Drawn by Dan Zuck on 4 December 1958, Arrow was the result of a request made to Johnson by the Land Panel during its November meeting to undertake a 'sanity check' of Convair's FISH proposal. Lockheed highlighted likely operational problems with the design, namely the unreliability of ramjets in cruising flight and the power deficiency of the proposed single JT12 turbojet to be used during the landing phase. (Lockheed Martin)

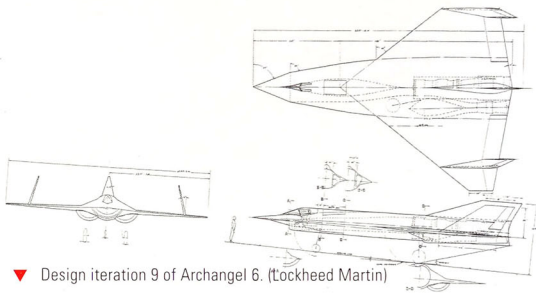




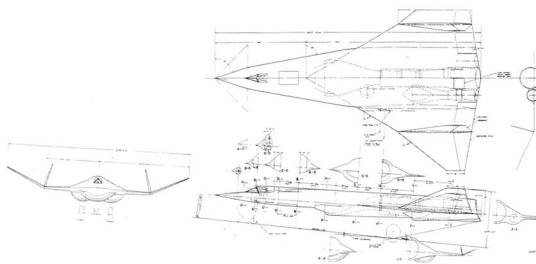
◀ Archangel 4. (Lockheed Martin)

▼ Archangel 5. (Lockheed Martin)

▼ Design iteration 6 of Archangel 6. (Lockheed Martin)



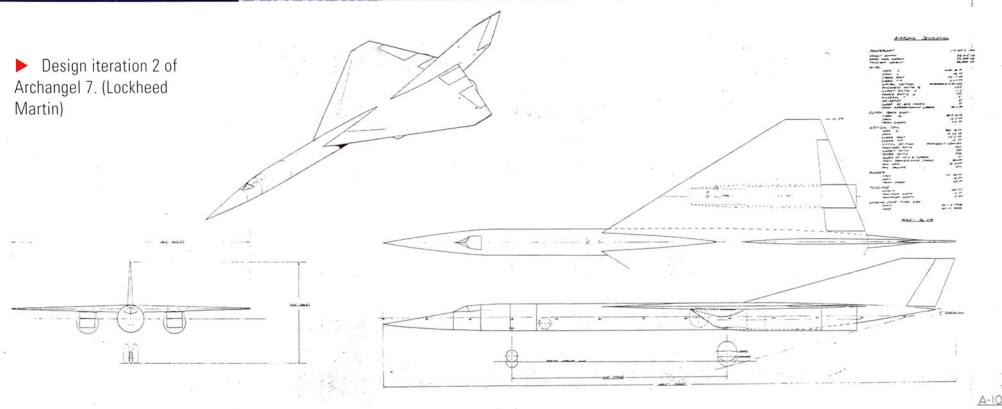
▼ Design iteration 9 of Archangel 6. (Lockheed Martin)



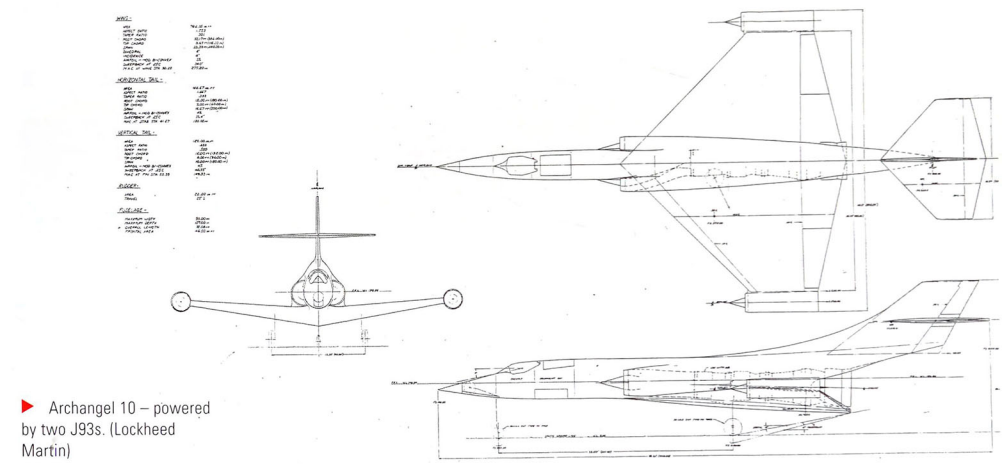
Five days after the Boston meeting, Johnson began making notes on what would become his A-3 design. Including two wingtip ramjets and two JT12A turbojets in the fuselage, Kelly assigned the concept to Dan Zuck, Ed Baldwin and Henry Combs. Continuing the angel theme, the team worked on several design permutations, referring to them as cherubs, since they were smaller than Archangel.

On 30 October Ed Baldwin completed the final A-3 design, which had a length of 62ft 4in., a span of 33ft 9½in. and weighed in empty at 12,000lb. Despite the relatively low levels of thrust generated by the two turbojets, it was believed that they were capable of getting the A-3 up to ramjet speed, which would then enable the vehicle to reach Mach 3.2 at a cruise altitude of 95,000ft; range was projected at 4,000nm. But weight issues dogged the design and when L. D. MacDonald and his team conducted RCS measurements on two scale models, the returns averaged out as the same for those of the U-2, which were much larger than for the all-metal Gusto 2S, which was itself larger than for Gusto 2A, which incorporated RAM.

On 12 November 1958, Johnson and Widmer presented their designs to the Land Panel – Johnson the A-3 and Widmer FISH. Three days later the panel communicated its findings to James Killian, the president's scientific advisor. Its recommendation was that FISH be selected, but should this design later prove unable to meet 'the desired technical features', the board would wish to review other alternatives before firmly recommending a second choice [the A-3]. Bissell called Johnson with the bad news on 26 November, pointing out that actually the two designs compared quite favourably, but the crunch issue had again been RCS, an area where Convair was still clearly ahead.



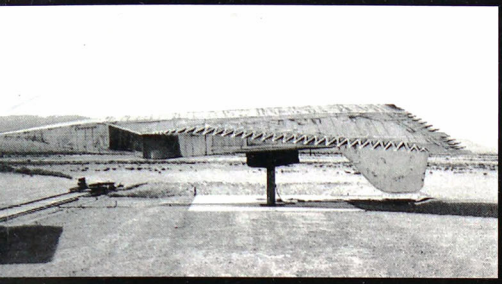
▶ Design iteration 2 of Archangel 7. (Lockheed Martin)

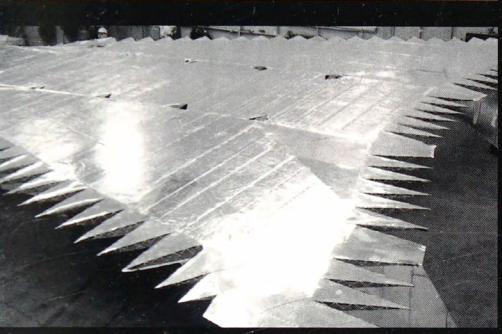


▶ Archangel 10 – powered by two J93s. (Lockheed Martin)

A major operational disadvantage of FISH was its reliance upon a carrier aircraft for launch. The board's decision to reject the A-3 had caused Johnson to focus his next set of designs on reducing RCS values to a minimum, while retaining the vehicle's ability to launch itself independently. Therefore, beginning on 26 November and over the next two months Johnson and his team worked on designs designated A-4, A-5 and A-6. They used an idea of Frank Rodgers' to incorporate chines beginning at or near the nose that blend into the fuselage and merge into the leading edge of the wings. The designs were also of small size, with their vertical surfaces hidden above the wings.

At the beginning of January 1959, before design studies had been completed on the A-6, Johnson instructed his team to work on a series of small non-stealthy designs designated A-7 through A-9. Each powered by a single J58 turbojet and two ramjets, none of the designs was subsequently judged to be viable; their range was inadequate, typically 1,640nm, and despite their size the RCS was too great.





▼ Kingfish under RCS test at the Indian Springs AFB Radar Test Scatter (RatScat) range. (Convair)

▲ Kingfish was Convair's heavily revised proposal following its failure to gain B-58B orders from SAC. (Convair)

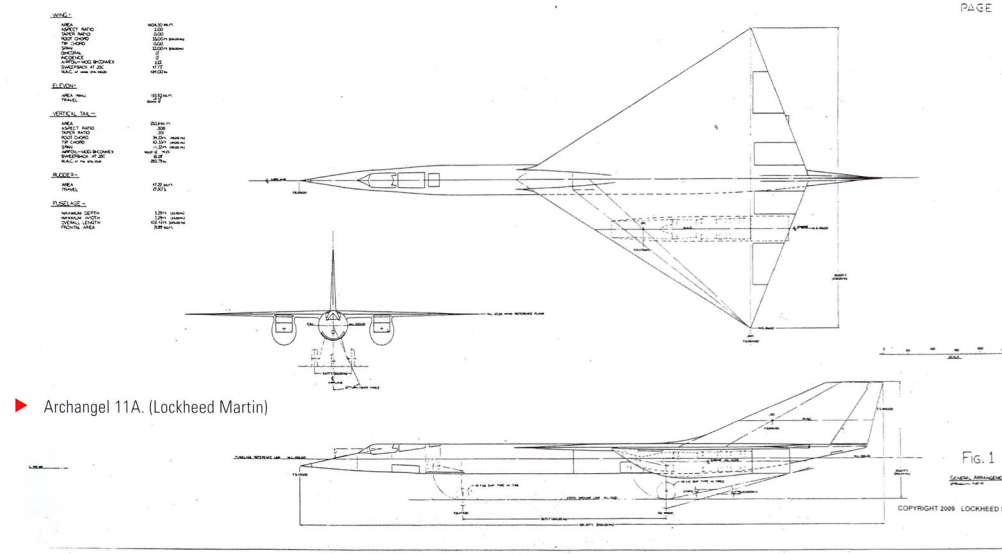
◀ The wing planform of Kingfish featured serrations to the leading and trailing edge into which RAM, capable of withstanding extremely high thermodynamic temperatures, was fixed to reduce the platform's RCS. (Convair)

Following the 12 November meeting, Convair began developing production plans, awarding subcontracts for the design of various subsystems in addition to conducting work that would refine and test various elements of its FISH design. It was during almost 300 hours of wind tunnel testing of 1/17-scale models that problems were identified. The drag coefficient acting on the B-58 with FISH in place was almost double that of a 'clean' aircraft. This meant that instead of the usual three minutes to accelerate from subsonic speed to Mach 2, it would take close to nine. In addition, FISH needed to be lengthened to improve stability and carry additional fuel; this meant the B-58 needed to be 5ft longer. Neither of these were issues for the B-58B since it was both longer and had uprated J79-9 engines, the problem was that the new bomber was as yet unfunded.

Having progressed through a series of small stealthy and non-stealthy designs, Johnson returned to his original Archangel concept for a purely performance-driven design with no concessions to reducing RCS. Pursuing this philosophy resulted in the A-10 and A-11 designs.

Employing the J93 turbojet, the A-10 was 16,000lb lighter than Archangel and therefore able to gain an additional 2,500ft at mid-mission altitude. It was able to cruise at Mach 3.2 at 90,500ft and had an operational radius of 2,000nm. However, it transpired that the J93 engines were 18 months behind the development of the J58, so in March 1959, the Lockheed team began work on what it believed would be its final major design in the series, the A-11. Designed specifically to use air refuelling, it would have a range in excess of 13,000 miles and complete an eight-hour round-robin mission from the United States without the inherent political and security issues associated with operating such aircraft from a foreign base.

Dulles, Bissel, Killian, Land and Purcell briefed Quarles and President Eisenhower on the progress of Gusto on 17 December 1958. The DCI reviewed the results of the U-2



▶ Archangel 11A. (Lockheed Martin)

missions to date and stated that he believed its successor 'would have a much greater invulnerability to detection'. Bissell then described the A-3 and FISH designs, noting that there was some deliberation whether the platform should be an air-launched or conventional take-off vehicle, adding that the next phase would be detailed engineering, at the end of which it was proposed that 12 aircraft be ordered at a cost of about $100 million. Eisenhower supported the purchase, but stated that more thought would be given to the matter before such an order was placed. Quarles then noted that the CIA, Department of Defense (DoD), and Bureau of the Budget (BoB) were working on a funding plan for the project. At the close of the meeting Eisenhower asked the group to return after completing the next work phase to discuss further stages of the project with him.

On 22 December, Convair was given the go-ahead to proceed with detailed design development of FISH. Twelve aircraft were to be bought and it was thought that a minimum of one B-58 launch aircraft would be required for every four FISH. Since SAC was operating a wing of B-58 bombers from Carswell AFB, the base provided ready cover and security for project FISH, and its close proximity to Convair's Fort Worth plant was also an advantage.

On 18 February 1959, following an internal CIA restructure, an office hitherto known as the Development Project Staff was re-designated as the Development Projects Division (DPD). One of the components of this organization was the 1007th Air Intelligence Service Group (AISG), which served as a cover unit for DPD Air Force assignees, but on 17 June this too was re-designated and became the 1149th Special Activities Squadron. It was this unit that would operate the new high-flier.

Nonetheless, on 18 May 1959, at the request of Gen Thomas White, Air Force Chief of Staff, a CIA/Air Force working level technical panel was formed to further examine the issue of finding a U-2 successor.

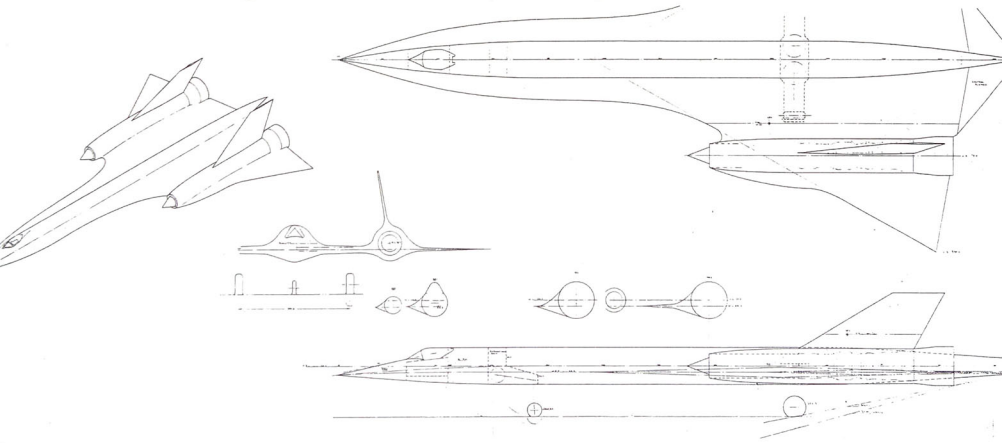
By the end of May the SEI team at Cambridge had completed a comparison evaluation

between the A-11 and FISH and its report, recommending the A-11, was forwarded to the Land Committee, which again met the two competing teams independently in Boston, on 9 June. The committee adjourned without making a decision. However, it did conclude that sporadic detection and tracking by radar was inevitable, regardless of the platform. On the flight back to Burbank, Johnson was convinced that Lockheed was out of the competition.

In the event it wasn't the Land Committee that decided the fate of the two designs, but SAC. In June 1959, Widmer accompanied his corporate boss, J. T. McNarney, and other senior Convair directors to a presentation to be given to senior SAC officers that included General Curtis LeMay (Vice Chief of Staff of the Air Force). Convair's objective was to sell the capabilities of the B-58B to the Air Force. However, to make the earlier B-58A commercially viable, the company needed first to sell more A models.

The presentation seems to have gone well. LeMay liked what he saw and asked, 'When can I have this?' Unfortunately for Convair, he didn't like the answer, and when McNarney told the notoriously fiery general that the B-58B would be available after SAC had purchased another three wings of B-58As, LeMay stormed out! Consequently the B-58B was never ordered by the Air Force, and without its mother ship, the parasite FISH wouldn't be built either. Convair was instructed to undertake a colossal amount of work, completely redesigning FISH as a single-stage platform that would not be reliant upon a mothership. Furthermore, it was stipulated that the new design should be powered by two Pratt & Whitney J58 turbojets.

On 3 July 1959, Richard Bissell, Director of the Program Office, visited Kelly and extended the Lockheed programme, agreeing to accept the lower cruising altitudes that would be obtained with a version of the A-11 adopted in shape and treatment to reduce its RCS. Kelly noted in his log, 'I proposed the A-12, with J58 engines in a mid-wing arrangement, the use of chines on the fuselage and serrations on the leading edge incorporating radar treatment.'



▲ Archangel 12. (Lockheed Martin)

The Convair team now pulled out all the stops, working through design iterations designated Smelt, Herring and, finally, Kingfish (which is perhaps as well, since it's difficult to imagine any pilot wanting to brag about flying an aircraft named Smelt). Remarkably, in just over two weeks it'd not only decided upon the basic design, but had also considerably modified the FISH radar model into the larger Kingfish configuration, and from 15 August 1959 used it to undertake a series of 70MHz radar tests at Indian Springs AFB – the results of which would turn out to be similar to those achieved by the A-12.

The origins of the basic Pratt & Whitney J58 engine (known to the manufacturer as the JT11D-20A) can be traced back to late 1956, when its centreline was laid down. The project propulsion team, led by William H. Brown, consisted of 27 engineers during the initial stages of the engine's design studies and development. They included William Gordon, the Pratt & Whitney Florida general manager, Don Pascal, Norm Cotter, Dick Coar and Ed Esmeier.

Initially a company-funded project, the US Navy began sponsoring its development to power a proposed Mach 2.5 attack aircraft capable of a dash capability up to Mach 3 for several seconds. Designed to generate 26,000lb of thrust with afterburning at sea level, the so-called J58-P2 engine successfully completed 50 hours of ground running acceptance trials in August 1958. However, the spiralling costs associated with the overall concept caused the US Navy to cancel the project (instead it ordered the McDonnell F4H, initially powered by two Wright J65 engines, later replaced by two General Electric J79-GE-2s).

By mid-1959, Pratt & Whitney had completed approximately 700 hours of full-scale testing on the J58. However, because of the sustained, extremely hostile environmental conditions under which the engine would operate in a Kingfish or A-12 application, the only design parameters that could be retained from the original P2 engine were its basic size and the compressor and turbine aerodynamics – and even these were modified at a later date.

Back at Burbank, L. D. MacDonald and Ed Lovick advised Dick Fuller how best to modify the A-11 design into the reduced RCS A-12. This included using chines – once these had been applied, a cross section of the fuselage forebody resembled a two-dimensional flying saucer! The wings were blended into the fuselage and engine nacelles, while the twin fins were made of composite material and canted inboard at 15°. Other more subtle RCS reduction innovations included incorporating Ed Lovick's serrations, applied to the wing leading and trailing edges as well as the chines, and filled with dielectric material. The A-11's rectangular inlets were replaced with round, axisymmetric units, while the translating spike used to regulate mass airflow into the inlet not only helped shield the engine compressor face from incident radar energy, but was itself covered in RAM. A proposal by Edward Purcell of the Land panel was also seized upon by the Skunk Works team, which used caesium as an additive in the fuel, decreasing the RCS of the engines' afterburner plume.

On 14 July 1959, Bissell and the Land Committee, together with James Killian, met and discussed the pros and cons of FISH, Kingfish, the A-11 and A-12, in addition to reports speculating about the possible capabilities of the new Soviet "Bar Lock" radar. As at the 9 June meeting, a final decision regarding which design to recommend wasn't made, but those present did begin to formulate a briefing to be taken by Dulles and others to President Eisenhower six days later.

On 20 July 1959, Dulles and the Land Panel informed President Eisenhower that Project Gusto was making good progress. Concerned about the U-2's continued vulnerability and the significant problems embroiling the Corona photo-satellite project, the president gave his final approval to the high-speed reconnaissance project.

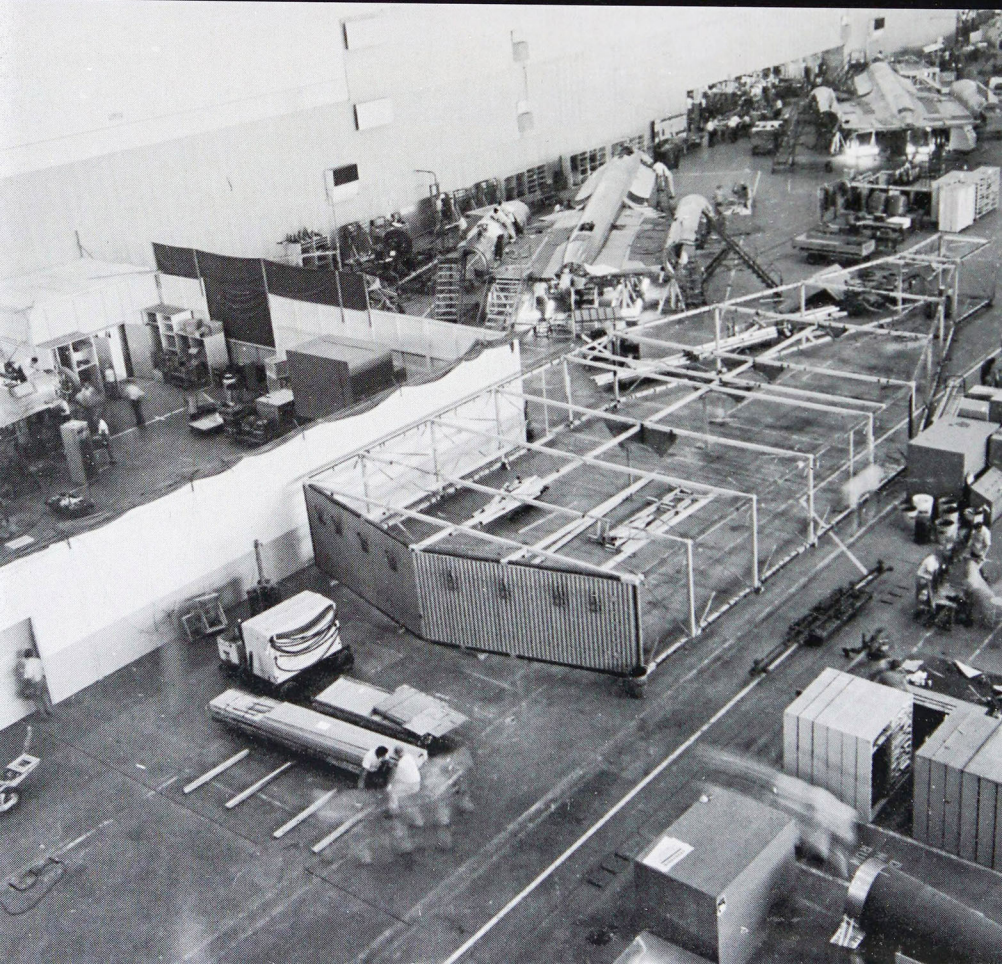
Final proposals from Convair and Lockheed were submitted on 20 August 1959 to a joint DoD, Air Force and CIA selection panel. Interestingly, despite the strikingly different external appearance of the two designs, their performance was very similar:

	A-12	Kingfish
Speed	Mach 3.2	Mach 3.2
Range (total)	4,120nm	4,000nm
Range (at altitude)	3,800nm	3,400nm
Cruise Altitudes		
Start	84,500ft	85,000ft
Mid-Range	91,000ft	88,000ft
End	97,600ft	94,000ft
Dimensions		
Length	102ft	79ft 6in.
Span	57ft	56ft
Gross Weight	110,000lb	101,700lb
Fuel Weight	64,600lb	62,000lb
First Flight	22 months	22 months
Cost summary (12 aircraft, no engines)	$96.6 million	$121.6 million

The Lockheed design was preferable in terms of overall cost, but in terms of vulnerability to radar detection the Convair design was superior, and some of the CIA representatives favoured Kingfish. However, Air Force personnel on the panel managed to convince them to support the Lockheed design on the basis that the cost overruns they'd experienced on the Convair B-58 project could be repeated by the company in this new high-risk programme, whereas Lockheed had produced the U-2 under budget and on time. Notwithstanding, despite its vote in favour of Lockheed, the panel was concerned about the A-12's inferior RCS results and therefore required the company to prove its concept for reducing the A-12's RCS by 1 January 1960.

Nine days later, Lockheed received official notification that its design had been selected by the board, and that it would receive $4.5 million by way of an advanced feasibility contract covering the period 1 September to 1 January 1960. Gusto was terminated and the new programme received the classified cryptonym Oxcart. John Parangosky, long associated with Aquatone, was appointed by the CIA as their project manager.

CHAPTER 3

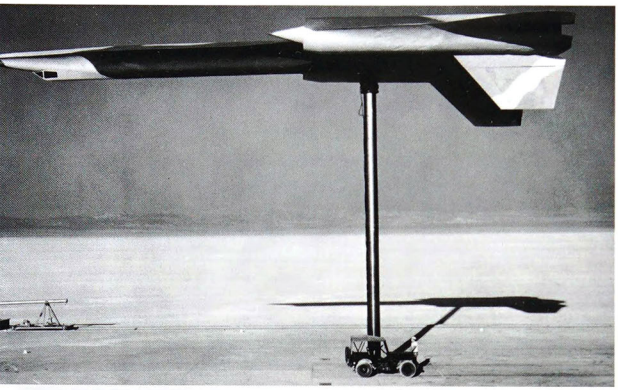


OXCART

On 31 August 1959, Lockheed began building both full-scale and ⅛-scale mock-ups in Building 82A for RCS testing. In addition it embarked upon an engineering reorganization and expansion plan.

The full-scale mock-up was to be tested independently by Edgerton, Germeshausen & Grier (EG&G) in cooperation with the SEI, at a small test site at Indian Springs AFB, Nevada. Lockheed objected to this on two counts: first, it claimed the pylon wasn't robust enough to support its full-scale model, and second, the site was in full view of a nearby highway. On 10 September, EG&G agreed to accommodate Lockheed's concerns by moving its radar test facility to Watertown Strip. With the facility relocated, replete with a larger pylon, the A-12 mock-up departed Burbank in a specially designed trailer on 10 November. Eight days later, the full-scale RSC test model was in place and testing could begin. They soon proved that the basic concept would work.

◀ The carriage frame under construction; placed around each A-12 and then covered with fabric, the frame helped maintain security as the aircraft were transported by road to Area 51. Note YF-12 construction under way in an area cordoned off from Oxcart production. (Lockheed Martin)



▲ The pole supporting this early A-12 model on the Area 51 RatScat range is yet to be wrapped in the RAM necessary before tests could proceed. (Lockheed Martin)

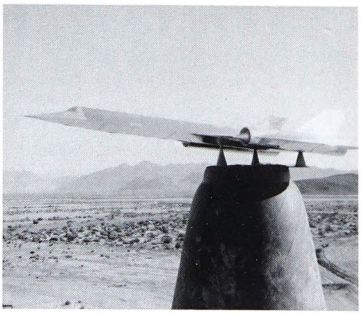
However, it took 18 months of testing and the incorporation of various design adjustments before the A-12 finally achieved a satisfactory RCS. These changes included adding thin curved extensions outboard of the engine nacelles that blended into the outer wing sections. A chine was added on each side of the fuselage forebody and the fins were canted inboard 15°. The new tail units were fabricated from resin-impregnated, non-metallic materials.

Later Oxcarts also incorporated 'edge softening' and their triangular titanium wing and fuselage fillets were substituted for units made from electrically resistive honeycomb asbestos. These were capable of withstanding the thermodynamic temperatures generated at high-Mach flight and absorbed incoming radar energy, rather than reflecting it, thereby further reducing the aircraft's RCS. Initially Johnson was concerned that these measures would have a negative impact on the aircraft's performance, but wind tunnel tests determined that the chines generated additional lift and improved the aircraft's handling qualities.

By mid-January 1960 the Skunk Works had successfully demonstrated that the A-12's RCS had been substantially reduced, but much to the chagrin of Bissell, the weight added in the process had affected the aircraft's altitude performance. Johnson therefore proposed a reduction of 1,000lb in the A-12's structural weight while increasing its fuel load by 2,000lb, ensuring that the proposed target penetration altitude of 91,000ft was achieved.

Satisfied with the changes, Bissell notified Johnson on 26 January 1960 that the CIA duly authorized the construction of 12 Oxcarts; the contract was signed on 11 February 1960. However, due to considerable unforeseen difficulties, the Skunk Works' original quote of $96.6 million proved more than optimistic. Fortunately for Lockheed, the CIA included a clause within the contract that allowed costs to be re-evaluated. It was a clause that had to be invoked on a number of occasions over the next five years as costs spiralled to more than double the original estimate. Meanwhile, events on the world stage were about to cause seismic tremors in the world of airborne strategic reconnaissance.

▼ This early pole model has vertical fins and rudders; the canted-in, all-moving tail units have yet to be incorporated into the design. (Lockheed Martin)



MAYDAY

Despite his misgivings, Eisenhower continued to sanction a limited number of U-2 Soviet overflights on the basis of the continuing need to collect intelligence and the ongoing failure of the Corona satellite reconnaissance programme. Then, on 1 May 1960, Soviet radar and SAM technology finally caught up with Project Chalice.

A U-2 flown by CIA pilot Francis Gary Powers was in the vicinity of Sverdlovsk, deep within the Soviet Union, when it was successfully engaged by an SA-2 "Guideline" missile. When the weapon's 180kg warhead, containing 3,600 shotgun-like pellets exploded, it peppered

▲ A-12 Article 133 serial 60-6939 on the Burbank assembly line inside Building 309/310 of Plant B6. (Lockheed Martin)

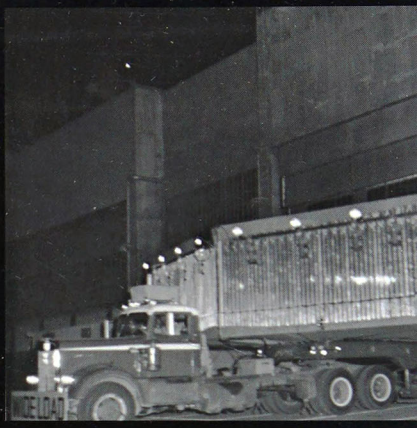
the U-2's tail and aft fuselage, causing catastrophic damage and throwing the aircraft completely out of control. Despite Power's best efforts, he was unable to activate the U-2's self-destruct explosive charges before escaping from the doomed aircraft. Consequently, instead of the craft's remnants descending to the ground as tiny pieces of confetti, it fell in large chunks.

As the hours ticked by and the aircraft failed to arrive at Bodø, Norway, its planned recovery airfield, a feeling of dread percolated through the project headquarters team back in Washington. In Moscow, Premier Khrushchev, a master of political intrigue and subterfuge, knew exactly how to play the situation; he said nothing and waited.

Two days later, under the assumption that Powers had been killed, approval was given by Eisenhower to put out a prearranged cover story in which NASA claimed that one of its U-2 research aircraft 'apparently went down' after the pilot 'reported that he was experiencing oxygen difficulties'. Khrushchev's bait had been swallowed hook, line and sinker; now he struck.

On Saturday 7 May, having returned to the Supreme Soviet, he revealed to the world the truth: 'We have the remnants of the plane – and we also have the pilot, who is quite alive and kicking!' The wreckage, maps and even film were recovered, proving beyond dispute precisely the reason behind the flight. Eisenhower was unmasked to the world as a liar. A subsequent mid-May summit meeting in Paris was a disaster, during which Khrushchev walked out after Eisenhower refused to apologise publicly for sanctioning the U-2 overflights (despite having assured the Soviet premier that there'd be no more such flights during the remaining eight months of his administration).

Unsurprisingly, a serious question thus arose regarding the future status of Oxcart. On



▶ A ten-wheeled Kenworth tractor unit hauling the A-12 prototype, Article 121, left Hangar 82, Burbank on 26 February 1962, at 3:30am. It arrived safely at Area 51 three days later. (Lockheed Martin)

▲ Dorsey Kammerer was appointed to head the effort to devise, build and implement the A-12's carriage system. Article 122 departed Burbank on 26 June 1962; Article 123 followed in August and the two-seat trainer, Article 124, in November 1962. (Lockheed Martin)

▶ On arrival at Area 51's main hangar complex, the articles were off-loaded for reassembly. (Lockheed Martin)

one hand, the shootdown vindicated the decision to develop a U-2 replacement, but on the other it opened up a debate as to whether the United States should continue violating Soviet airspace with its manned strategic reconnaissance programme. An insight into the president's thinking on the subject can be gained from a top secret memo for the record, dated 2 June 1960 and written by Brig Gen Andrew Goodpaster, military aide to President Eisenhower.

> I spoke to the President early this week about the question of whether work should go forward on the successor to the U-2. After considering the matter, he said he was inclined to think that it should go forward, on low priority, as a high performance reconnaissance plane for the Air Force in time of war. I suggested it might be useful for Mr Allen Dulles [DCI], Mr Gates [Thomas Gates – defence chief] and Mr Stans [Maurice Stans – Budget Bureau Chief] to get together to consider the matter, and he agreed. He said he did not think the project should now be pushed at top priority. In fact, they might come to the conclusion that it would be best to get out of it if we could. Alternatively, they may feel that we have so much invested in it that we should capitalize on this through carrying it forward.

Meanwhile, the Skunk Works team had mountains to climb before Oxcart was anything like operational. It's a story best told by Kelly Johnson through his log, where the first hint of trouble appears in an entry dated 17 August 1960: 'The time has come when I have to announce officially, as well as unofficially, to the customer that we are late. Because of extreme

costs of machining, we are probably going to be over cost'. Four months later Johnson's woes were further exacerbated: 'Have a very strong suspicion that P&W are not going to meet their schedule. They have run into trouble on the compressor with the tip shrouds. Of course they didn't mention this as being a problem.'

On 13 February 1961, the Skunk Works had more problems: 'Having trouble with wing load distribution and have to put a twist in outboard leading edge.' In March Kelly informed the CIA's Deputy Director for Plans (DDP) Richard Bissell that 'schedules are in jeopardy on two fronts. One is the assembly of the wing and the other is in satisfactory development of the engine. Our evaluation shows that each of these programs is from three to four months behind the current schedule.' Bissell's response was curt: 'I have learned of your additional expected delay in first flight from 30 August to 1 December 1961. This news is extremely shocking on top of our understanding as of our meeting 19 December that the titanium extrusion problems were essentially overcome. I trust this is the last of such disappointments short of a severe earthquake in Burbank.'

Things continued on a downward spiral when, on 12 April, Kelly noted in his diary:

> Some time is starting to build up on the wing. The fuselage looks in good shape. Fighting a whole host of problems on powerplant, ejectors, plumbing, material shortages, lack of space. We are going to fly early in December on some basis, but it's going to be an extremely busy summer and fall. Working three shifts in all critical areas.

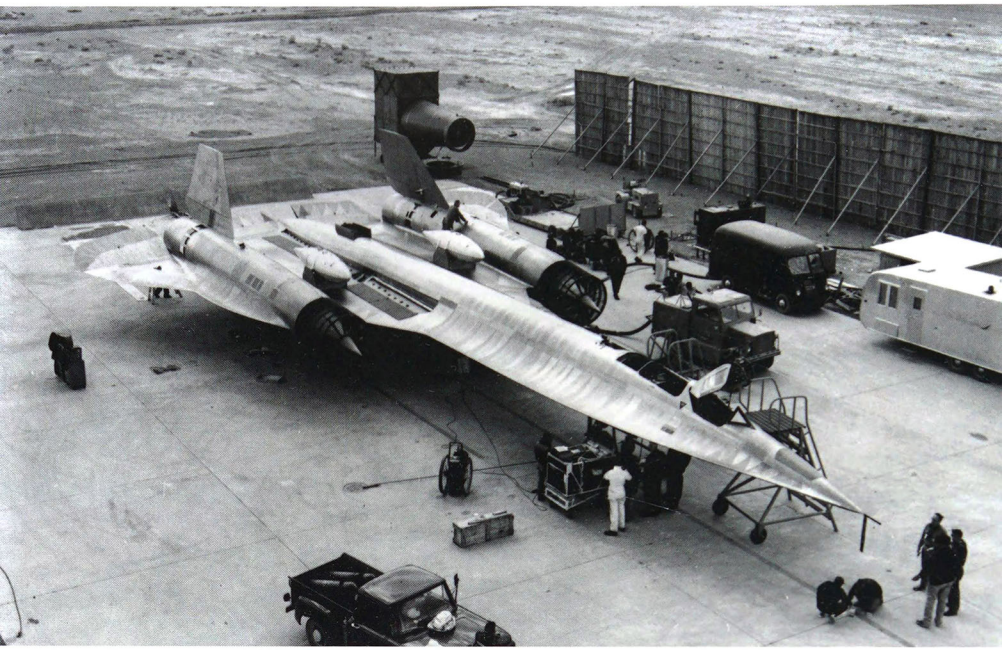
On 9 September the aft wing section and forward fuselage were removed from their jigs and mated together perfectly. But this piece of good news became almost insignificant just two days later, when Kelly received word on the J58 engines.

> The day started with P&W coming in prior to the suppliers' meeting and stating that the engines would be 1,000lb apiece overweight, considerably down on performance, and that it would be about March 1962 before we got engines. I was in deep shock for the next week.

Pratt & Whitney provided a little more clarity on the engine issue on 28 September. 'P&W told us the story on the engine, and said that the best delivery date we could get for two engines was March 1962. (They admitted this meant April, or March 31.)' The next day Kelly wrote, 'After a sleepless night, I decided that we would have to try to fly with a J75 engine, doing everything possible to raise the take-off power, such as using water injection, and higher take-off rpm temperatures, and higher take-off rpm.' The specific engine chosen as an interim replacement for the J58 was the J75-P19WSS, and between 3 and 5 January 1962 Kelly spent time with the engine manufacturer.

> Had a big meeting with P&W in Florida. I spent a day alone with them. Their troubles are desperate. It is almost unbelievable that they could have gotten this far with the engine without uncovering basic problems which have been normal in every jet engine I have ever worked with… Hamilton Standard are not covering themselves with glory either. It's a good thing we went to the J75, although these engines, too, have troubles and require new compressor discs.

At the beginning of February Johnson wrote, 'Going all-out on finishing airplane #1. Everyone is putting in very long hours and meeting a tough schedule, outlined in one of my project



▲ During the course of engine and fuel-flow tests serious leaks were discovered; external fuel tanks were used so that tests could continue. (Lockheed Martin)

memos. We are having trouble with high temperature greases, bearings and the usual host of last minute troubles.' Then, at last, on 26 February, 'The convoy left at 3:30am to go to the area. Everything went smoothly and it arrived at 1:00pm Feb. 28. Dorsey [Kammerer] did his usual splendid job of organizing the move.'

Then just as everything looked like plain sailing, the 6 March entry recorded, "Fuel put in the bird. It developed 68 leaks. Was first told that the sealing looked good, but later investigation showed that we had no adhesion to speak of between the Viton compound and the titanium. This is a cruel blow, as it will delay us a month or more.' At last, in the 25 April entry, 'Went to the area and stayed overnight. Made our first flight under very different conditions.'

Oxcart chief test pilot Lou Schalk takes up the first flight story.

> It all went like a dream until I lifted off. Immediately after lift-off, I really didn't think I was going to be able to put the aircraft back on the ground safely because of lateral, directional and longitudinal oscillations. The aircraft was very difficult to handle, but I finally caught up with everything that was happening, got control back enough to set it back down, and to chop engine power. Touchdown was on the lakebed instead of the runway, creating a tremendous cloud of dust into which I disappeared entirely. The tower controllers were calling me to find out what was happening and I was answering, but the UHF antenna was located on the underside of the aircraft (for best transmission in flight) and no one could hear me. Finally, when I slowed down and started my turn on the lakebed and re-emerged from the dust cloud, everyone breathed a sigh of relief.

From the ground Kelly recorded.

> Flew about 1½ miles at altitudes of about 20ft. Aircraft got off the ground with lots of right rudder on, and then required change of rudder angle to 24° immediately. This set up lateral oscillations, which were horrible to see. We were concerned about the ability of Lou Schalk to stop, but he did this very nicely, without severe braking. The lake is soft enough so that we can roll onto it at fantastic speeds and stop readily. Actual trouble was later shown to be due to nose wheel steering problems.

It was decided to attempt another flight the next day, as Kelly noted.

> We rolled out early, and at 07:05 made a beautiful take-off. However, due to failure of a forward fillet bracket, we shed almost all the left hand fillets and one from the right side, starting before we left the runway. Fortunately, I had spent the previous day with Lou Schalk, explaining that the fillets were non-structural and that we might have troubles. Beautiful landing was made, and in flight we investigated the effect of the stability augmenters. We showed that the first flight troubles were not caused by basic aircraft stability.

▲ Lou Schalk (centre, in flight suit) is congratulated by Agency and Lockheed officials, following successful completion of the Oxcart's first 'official' flight on 30 April 1962. Note F-104 Starfighter in the background used by Jim Eastham as a chaseplane on the sortie. (Lockheed Martin)

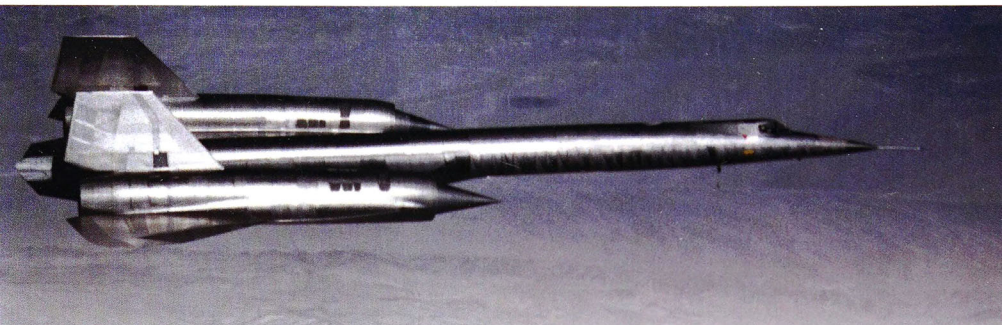
The first official flight took place four days later on 30 April 1962. During the 59-minute flight, the Oxcart (at 72,000lb gross weight) lifted off at 170kt. The landing gear was retracted and the aircraft climbed easily to 30,000ft, where it attained a top speed of 340kt. With the second flight test objectives achieved, the gear was extended and Lou brought the prototype safely back to roost. On 4 May, during a 1-hour 10-minute flight, Schalk took 121 supersonic for the first time.

When word of these initial successes were passed to Washington DC, John McCone, the new director of the CIA, telegrammed congratulations to Kelly, but the programme was a year behind schedule and much work still remained to prepare the new aircraft for its operational debut.

RECRUITING THE PILOTS

Despite issues arising from Powers' shootdown, CIA flight crew selection began in 1961, following a system developed by Col Houser Wilson (the Pentagon's Special Activities Office representative) and Brig Gen Jack Ledford (the Agency's USAF liaison officer, later succeeded by Brig Gen Paul Bacalis). Ken Collins, one of the first pilots recruited into Oxcart, recalls the process.

> The primary professional selection criterion was that a pilot should have more than 1,000 hours in 'century' aircraft and a total of 2,000 flight hours. At the time, I was an experienced instructor pilot in the RF-101, having over 50 air-air refuelling training sorties and about ten transatlantic deployments, each with multiple air-air refuellings. This was the easy part of the Pentagon selection process. Either you had it or you didn't. All of your flight, professional and medical records were meticulously scrutinized



▲ Article 121, up for a test flight on 10 July 1962. During the aircraft's second flight on 4 May 1962, it achieved Mach 1.1 at 40,000ft, despite being powered by two J75 engines. (Lockheed Martin)

at all levels before your name was released for further evaluation.

On the personal side of things, they were adamant that you were married, preferably with children – this was because they'd experienced problems with the previous U-2 programme. Their rationale was that the family unit was more socially established, dedicated and dependable. Later during the process our wives were interviewed and evaluated separately; expanded background investigations were also run on them. My wife Jane was told that she wasn't to talk to anyone about the interviews, neither was she told what I'd be doing. She could if asked say that I had decided to resign from the Air Force and work for Hughes Aircraft.

At this stage in the proceedings (April 1961), we didn't know what we were being evaluated for. Each of us was separately tasked for these various events. For example, I was unaware that another pilot from Shaw AFB, Capt Walter Ray, was also undergoing these interviews and evaluations. We started running into each other about a year later, when the field of consideration was narrowed by elimination. From day one you were given the option of withdrawing from the selection process at any time, without prejudice – an option that remained throughout the programme.

Our medical records were acceptable for the initial evaluation, because we were all on flying status; however, they weren't extensive enough as the selection process continued and we were all about to find out what that really meant. I was scheduled for my 'astronaut' physical examination at the Lovelace Clinic, in Albuquerque, New Mexico. This is the same facility in which the original astronauts and the early U-2 pilots received their medical evaluations. The clinic was founded by Dr Lovelace, one of the pioneers of aviation medicine and his work was continued by his son, Dr Randy Lovelace, until he, his wife and their pilot were killed in a flying accident.

My government contact at the clinic was an Air Force flight surgeon. He established my schedules and appointments and observed the tests; we also had dinner together, but this was more as part of the evaluation than being social. I arrived on a Sunday and departed the following Saturday; during those five days they checked out every bodily orifice, X-rayed me from head to toe, flushed me out and took samples and measurements of everything – I even had to carry a large brown bottle around for 48 hours to collect every drop of urine. They also conducted extensive EKGs and EEGs. I was hydrostatically weighed in a large water tank, ran the bicycle pulmonary functions and passed other physical stress exercises. They then flew me to Los Alamos Laboratory to be inserted into the 'body counter'. This mapped fat versus muscle tissue in the body and when correlated with the data from the hydrostatic weighing, it theoretically enabled them to determine total body capacity, regardless of size. After that I was ready for the hospital.

I was also subjected to many different types of personal and professional evaluations. In Philadelphia, I was put into a soundproof black box, where I had to remain in total

darkness and without sleep for 12 hours. Then there was a polygraph and numerous dinners and lunches with a variety of people with 'professional', medical, intelligence and senior manager backgrounds, all there to get an opinion. After all the sorting was nearly complete, I learned that eight people would be selected for the initial programme; this sounded reasonable, since that was the average group size for the astronaut programme.

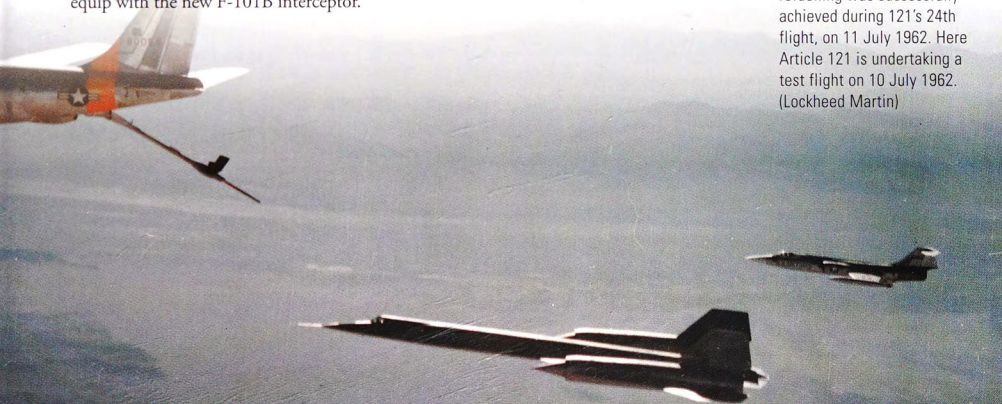
Finally I received orders assigning me to Headquarters USAF, at the Pentagon, where I was to report on 28 October 1962. The packers had completed their task, but the night before Jane and I were due to leave Shaw AFB I received a phone call from Lt Col Clyde East, my squadron commander over at the 20th TRS, instructing me to report on base immediately, because the unit's RF-101s were on alert for immediate deployment to MacDill AFB, Florida, as what came to be the Cuban Missile Crisis had just erupted. I would have liked to deploy with my squadron, but clearly and unknown to them, other things were happening in my flying career.

Having been informed earlier that my new assignment wasn't into the astronaut programme, but a project to fly and test an exotic new airplane for the CIA, I was again offered the option to withdraw; there were still no pictures of the aircraft or any other details, but I declined to opt out. On arrival in Washington I met other successful candidates that were soon to become close colleagues, Bill Skliar, Lon Walter and Walt Ray (who I already knew from Shaw). I signed on the dotted line and was told that I was to be in LA by November and that further contact and instructions would follow when I got there; so the next day Jane and I, together with our four kids, headed west.

In addition to Ken Collins, the other pilots that successfully completed the project' arduous selection process were Jack Layton, Dennis Sullivan, Mele Vojvodich, Jack Weeks, William Skliar, Walter Ray, Alonzo Walter, David Young and Russ Scott.

Frank Murray joined the programme via a more circuitous route. Graduating from the USAF Aviation Cadet Program as a pilot at Laredo AFB, Texas, in Class 53C (he completed the course in May 1953), he underwent gunnery training in the T-33 and F-84B and F-84C. He then went to France, completing his first operational tour with the 48th Fighter-Bomber Wing, flying the F-84G and F-86F, before returning to the United States to fly F-84Fs with SAC.

In early 1957, he was reassigned to another SAC wing, flying F-101As and Cs at Bergstrom AFB, Texas. In 1958 the wing disbanded and its aircraft were sent to the 81st Tactical Fighter Wing at RAF Bentwaters, England. Having recently returned from a tour of duty with United States Air Forces in Europe (USAFE), Frank was posted to the 60th Fighter Squadron, an Aerospace Defense Command unit based at Cape Cod, Massachusetts, that was about to re-equip with the new F-101B interceptor.



▼ The first A-12 air refuelling was successfully achieved during 121's 24th flight, on 11 July 1962. Here Article 121 is undertaking a test flight on 10 July 1962. (Lockheed Martin)

▲ Bill Park was the second test pilot to fly the A-12; he's seen here later, during U-2R trials. (Lockheed Martin)

Cape Cod was Frank and his wife Stella's home for the next five years, at the end of which he volunteered to become a NASA support pilot. Little did he know that this was a cover used by the CIA to entice USAF fighter pilots to put their names forward, creating a list from which it could select pilots and support staff for the Oxcart programme.

Like all those selected, Frank had an outstanding military record, with over 1,500 hours on the F-101 in his logbook. He arrived at Area 51 in July 1963 as an instructor and chase pilot in the F-101, checking out other pilots on the aircraft, conducting chase duties and performing routine proficiency and instrument flight checks. By 1965, some of the earlier Oxcart pilots had elected, for various reasons, to opt out of the programme. Frank was approached and asked if he was interested in becoming an A-12 driver. He leapt at the chance and became, as he puts it, the 'junior wienie!' Of the pilots on strength, only six would eventually take the Oxcart to war – Vojvodich, Weeks, Layton, Collins, Sullivan and Murray.

On 15 November 1961, Col Robert Holbury was appointed base commander of Area 51, as Watertown or The Ranch were more officially known. Other members of his staff included Col Doug Nelson, his Director of Operations (DO); Lt Col Anderson, Assistant DO; Lt Col Barrett, Chief of Base Operations and Chief of Standardisation and Evaluation (Stan/Eval); Lt Col Ray Hampt; and Maj Burgeson.

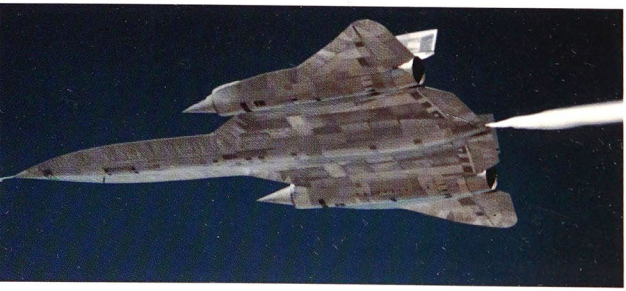
A-12 BUILD UP

On 6 July 1962, Kelly had at least put his overcrowding problem to rest when he noted: 'Opened our new engineering building, #311. This is the fifth Skunk Works building, and it is very nice.'

Lou Schalk had been contracted to perform the first 12 Oxcart experimental test flights, but an element of superstition led him to also fly the 13th, after which he was joined by another Lockheed test pilot, Bill Park. By the end of the July 1962, the prototype A-12 had completed its 28th sortie and flight test was proceeding well. Aircraft number two (Article 122) had arrived on 26 June, but was mounted on the pole at the Area 51 RatScat and although the first RCS test results were up 5 to 10dBs, this wasn't unexpected.

With still no sign of the J58, the CIA became increasingly impatient to see progress in return for its Oxcart investment. Some senior Agency officials decided that the A-12 should be capable of Mach 2.0 with its twin J75 powerplant, since these were the engines that powered the USAF's Mach 2.0 Convair F-106 Delta Dart interceptor. They did not seem to understand that the A-12 had been designed to house a pair of J58s and that the J75s were mismatched with the inlet systems; this caused an inlet airflow vibration or 'duct-shudder' as Mach 2.0 was approached. However, in order to placate the directors who controlled the Agency's purse strings, Bill Park dived an A-12 to Mach 2.0, and this relieved at least some of the high-level pressure on the design team.

▼ The bare metal finish of Article 121 shows to good effect the serrated edging applied to the fuselage and wing. It was filled with RAM on later aircraft. (Lockheed Martin)

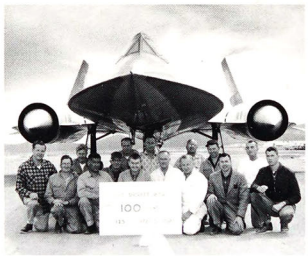


In July 1962, the J58 had finally

completed its pre-flight rating test and the prototype was transported to Area 51. It was installed in Article 121's left nacelle, and until confidence levels in the new engine grew, the aircraft flew with a J75 in the right nacelle. But there were problems. One early hiccup was ignition – the engine simply wouldn't start, no matter what procedure was tried by the Pratt & Whitney engineers.

▲ Having completed RCS ground trials in November 1962, Article 123 joined the flight test programme. Like its predecessor, ship two was initially equipped with J75s. (Lockheed Martin)

The small inlet wind tunnel model had not revealed that the engine's appetite for air was so great that flow reversal occurred. Instead of flowing out of the compressor's fourth-stage bleed ducts, air was drawn into the compressor from the back end. As a temporary fix, Lockheed removed an inlet access panel to facilitate ground starts. It subsequently cut holes in the rear section of the nacelle and installed two sets of suck-in doors, while Pratt & Whitney added an 'engine bleed' to the nacelle to improve airflow through the powerplant during ground starts.



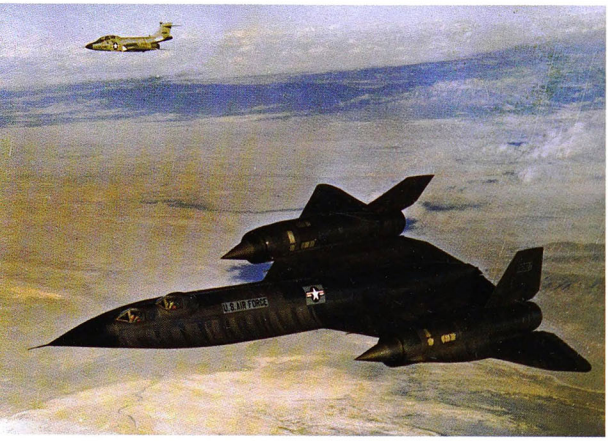
◀ Although slow to begin the test programme, Article 123 was the first A-12 to clock 100 hours, a total reached on 3 April 1963. Jim Eastham is sitting immediately behind the signboard in the centre; Dorsey Kammerer is rear row at far left. (Lockheed Martin)

Finally, on 5 October 1962, 121 flew with one of its new engines, but Kelly was not impressed, as he noted: 'It is down in thrust; fuel control is inconsistent; there are thrust jumps at different throttle positions; and we have continual trouble with the afterburner lighting system and plugged spray bars.' On 16 August, Jim Eastham joined the flight test team and that same month aircraft three (Article 123), arrived at Area 51. It didn't fly until October, a month that proved significant for Oxcart.

THE CUBAN MISSILE CRISIS

On 14 October 1962, Maj Steve Heyser's historic U-2 overflight of Cuba captured undeniable photographic evidence of the presence of Soviet SS-N-4 medium range ballistic missiles (MRBMs) and SS-N-5 intermediate range ballistic missiles (IRBMs) on the island. Consequently, U-2 overflights were increased to a peak level of five per day.

On Saturday 27 October 1962, Maj Rudolph Anderson was shot down by an SA-2 while flying a U-2 over Cuba. Once again the type's vulnerability had been demonstrated in most spectacular fashion. Anderson was killed in the shootdown, which served to reinvigorate the Oxcart programme; the achievement of operational status for the A-12 became a high national priority.



▲ Article 124 was the only two-seat pilot trainer built. Powered by J75s, it was restricted to 'low' Mach and 40,000ft, negating the need for crewmembers to wear a pressure suit. (Lockheed Martin)

After completing more than 15,000 RCS tests, 122 was finally removed from the RatScat pole on 2 November 1962, and the results of its trials reviewed and passed by the CIA project office. Elsewhere, 'problems continued with P&W and Hamilton Standard, as Kelly wearily noted on 14 November: 'Deliveries were practically stopped by lack of Hamilton Standard fuel controls; the thrust of the engine is down, specific fuel consumption up. The initial engines would not run well above 75,000ft. They showed their program for getting the performance back, but this could not be accomplished until engine #19, due for delivery in April 1963.' Aircraft five (Article 125) was delivered to Area 51 on 19 December, minus engines – but at least Lockheed met its schedule requirements for the year.

Aircraft four (Article 124) was the only two-seat pilot trainer and, like its stablemates, was due to be powered by J58s. However, given the ongoing engine shortage, it was decided to equip it with J75s throughout its lifetime. Once pilots had checked out, they'd go on to high-Mach flight in a single-seater. Once this decision had been reached the aircraft (nicknamed 'the Titanium Goose') undertook its maiden flight in January 1963.

When some of the Agency pilots first saw the A-12 they were eager to confer a nickname upon Kelly's new Skunk Works masterpiece. Aware of Lockheed's penchant for christening its designs after celestial bodies, Jack Weeks came up with Cygnus (the Swan), the name of a constellation in the northern celestial hemisphere, lying between Pegasus and Draco in the Milky Way. The name was particularly apt for the secretive A-12 programme because research astronomers believe that Cygnus may contain one of the most mysterious of nature's invisible bodies – a black hole.

PALLADIUM

Concern was voiced in some quarters over the Oxcart's ability to avoid detection by Soviet radars. Under an ongoing effort to measure the range and power of various Soviet defence radar systems, the CIA implemented the Quality ELINT programme. A highly classified element of that programme was code-named Palladium. Its objective was to determine the sensitivity of various Soviet radars.

To achieve this, a special electronic transmitter capable of projecting a 'ghost signal' onto a P-12 "Spoon Rest" surveillance and missile acquisition radar was developed. The knowledge gained from the Quality ELINT power and coverage measurements enabled technicians to simulate an aircraft of any RCS and 'fly it' along a path at a pre-determined speed and altitude. By electronically varying the size of the radar returns and enlisting the co-operation of the National Security Agency (NSA), which intercepted and decrypted the relevant communications channels, it was possible to determine a radar's sensitivity based upon which signals were being tracked.

During the Cuban Missile Crisis, the US intelligence community had monitored the construction of no less than 19 SA-2 SAM sites on the island and these provided the CIA, together with Oxcart planners, an ideal opportunity to determine the sensitivity of its associated radar receiver. One night, a US Navy destroyer equipped with a Palladium transmitter positioned itself beyond the detection range of a Soviet P-14 "Tall King" A-band early warning radar situated near Havana.

With its antenna protruding just above the horizon the destroyer produced a signal that appeared to be emanating from a US fighter out of Key West, making a high-speed dash towards the capital, Havana. At a predetermined time, a US Navy submarine surfaced near Havana Bay, just long enough to time-release a series of balloons carrying radar reflectors of varying sizes. The idea was that having detected the 'aircraft', the Soviets would switch on SA-2 target tracking radars in preparation for engaging the target.

Release of the balloons ahead of the 'target' would produce a number of returns, of which the smallest reported would present the highest level of radar sensitivity. The operation worked like clockwork. Cuban interceptors were also scrambled to hunt down the 'intruder', and when one of their pilots told his ground controlled intercept (GCI) controller that he had acquired the 'target' on his radar, the technician on the destroyer flicked a switch and the 'US fighter' disappeared.

After analyzing the intelligence data collected from this operation and by other means, the CIA's OSI concluded that Soviet radar capability would indeed be able to track and 'lock on' to an Oxcart, despite the aircraft's radar attenuating design features. Despite these discouraging findings, flight test continued.

On 15 January 1963, Bob Gilliland became the fourth member of the Lockheed flight test team. That same day also marked the first time that an A-12 took to the air powered by two J58s. By the end of the month, ten J58s were available, but Kelly noted on 20 March: 'We have been to 2.5 Mach and as high as 70,000ft, but we are in trouble from Mach 2.0 up'. These J58 powered flight results were not at all encouraging for Lou Schalk, and he confided in Bill Park, who had chased him in an F-104, 'Look Bill, you're going to fly this airplane pretty soon, but don't say too much about how bad it accelerates, we're never gonna make Mach 3. But let's not get this programme cancelled 'til someone figures out how to make this thing run right.' After Park flew Article 121 equipped with the two J58s he said, 'Lou, you're right, but let's keep it under our hats.' Perhaps the two test pilots were joking, but there was clear cause for concern.

On 2 May 1963, Kelly went to Area 51 to investigate why it was proving so difficult to get past Mach 2.0. He wasn't impressed when he discovered the reason. 'It develops that Hamilton Standard had changed the gain on the spike control of the cam designed jointly by Rich and Hamilton Standard, and the main control contributed to the instability. Greatly displeased that Martin, Rich, Bohanan and Hamilton Standard could not find this out on their own, and no one seemed to know which controls gave which performance, until I made

▼ Wearing the early black and bare titanium paint scheme, Article 130 successfully completed its first flight on 27 November 1963. (Lockheed Martin)

▲ Article 124, seen from the tanker boom operator's position. (Lockheed Martin)

a review of the ships' records, and it became perfectly clear.'

As the J58 flight test programme progressed, yet more issues surfaced. Heavy wear and cracks on the long drive shafts between the engine and its remote gearbox became a problem, together with twisting and heavy spline wear. This was caused by a 4in. displacement of the gearbox relative to the engine during high-Mach transients. A double universal joint on a new shaft between the two components solved that problem. It was also discovered that the fuel system ahead of the engine showed signs of fatigue and distortion. Measurements from a fast recorder showed that pressure levels at the engine fuel inlet were going off the scale. This over-pressuring was caused by feedback from the engine hydraulic system. The phenomenon had failed to materialize in rig tests and during engine ground tests because large fluid volumes were not involved.

Resourceful as ever, the Skunk Works invented a 'high temperature sponge' – promptly named the 'football' – that was installed ahead of the engines and reduced pressures to more tolerable levels. Yet another problem turned up during certain manoeuvres that crushed engine plumbing. This was found to be a result of the outer half of the nacelle rotating into the engine. Pratt & Whitney solved it by redesigning the rear engine mounting and incorporating a tangential link between the underside on the engine and the outboard side of the nacelle. A finite distance was thereby always maintained between engine and nacelle.

As greater speeds and altitudes were attained, cockpit cooling became an issue. Bill Park recalled that the control stick got so hot that he had to change hands regularly to keep hold of it, even though he was wearing his pressure-suit gloves. In fact, temperatures got so high in the upper areas of the cockpit that temperature-sensitive material patches on the pilot's helmets were blackened, indicating that 130°F (54°C) had been reached. By redirecting the incoming flow from the AiResearch air conditioning unit and employing a special bootstrap-cooling unit, the Skunk Works eventually provided a tolerable cockpit environment.

PROJECT PILOT TRAINING

Ken Collins recalls his flight training for Oxcart:

> I began flying training by rechecking-out in the F-101. Since I had already accumulated over 1,000 hours in the RF-101A, C and B (Trainer) as a combat-qualified crewmember and flight instructor less than three months before, this was achieved in short order. All flying was accomplished in accordance with current Air Force standardization and evaluation regulations.
>
> The project pilots studied existing A-12 procedures documents, and reviewed the systems with aircraft systems engineers and the Lockheed test pilots: they also got all the cockpit familiarization time possible. It's important to point out that during these early days there was little in the way of established test data and procedures. Kelly Johnson repeatedly said that this was a truly experimental test program. The systems were new and untried, so changes evolved and were being made daily with the

completion of each test flight. Procedures were developed in flight, and during the debriefings. Every flight was critically reviewed by the project pilots, the system engineering staff and the Lockheed test pilots.

A-12 flight training began with three or four flights in the AT-12 trainer, which was equipped with J75 engines and afterburners. The cockpit and flight systems were basically the same as other A-12s, but the trainer would only get out to Mach 2+. There was no flight simulator, so the trainer was the best available and it was good. My first A-12 trainer flight was on 6 February 1963. Bill Skliar was the first project pilot to fly the aircraft and he checked out two days earlier; Walt Ray followed me on 10 February and Lon Walter sometime after that – Lon opted out of the programme shortly after he started flying the J58 A-12. Take-offs and landings were very similar to the operational A-12, as was air refuelling. I wanted to ensure that I got all the trainer flight time possible in preparation for my first flight in the single-seater, equipped with J58 engines.

The most critical event that the trainer could not prepare you for was the inlet unstarts, because it didn't have a variable geometry inlet and could not get to Mach 3. Other important points at this juncture:

1. The A-12 did not have aft bypass doors;
2. Did not have spike and door position indicators;
3. Only had spike/door restart switches;
4. The fuel controls were unreliable;
5. The inlet controls were unreliable.

As soon as possible after the A-12 trainer checkout, we were put on the A-12 schedule. Once there, every flight was different, with the exception that every flight had multiple inlet unstarts. When you began the climb and acceleration out to 80,000ft and Mach 3, you were certain that there would be a 'popped shock' and an unstart between 2.5 Mach and 2.9 Mach. You never knew the extent of these. True to say, however, that all unstarts were severe and serious in the beginning.

The problem was that since we only had a toggle switch for each inlet (no inlet position indicators until much later) we were reacting, usually too late, to an unstart that was already in progress. An inlet unstart 'popped' the shock out of the throat of the inlet, immediately stopping the airflow through that inlet and causing an engine compressor stall and afterburner blow-out, both of which were essential to your acceleration and retaining altitude.

At this phase of the test programme you were only guessing which system unstarted, left or right. For any hope of restarting the inlet and continued acceleration, you hit both inlet toggle switches immediately. By making a quick guess you reactivated that inlet toggle hoping that you could catch it before the unstart compressor stalled the engine and blew out the afterburner. Even after guessing right, you were usually too late, because it all happened in a nanosecond. After the unsuccessful attempt to get an immediate restart, you were in for head knocking, rapid deceleration and a shuttering dive toward the ground. At this point, you weren't concerned about the inlets, your primary efforts were directed toward getting the engine restarted, because the severity of the initial inlet unstart placed the aircraft in a hard yaw, which then caused the other inlet to unstart, which in turn caused that engine to compressor stall and the other afterburner to flame out, leaving you with an even more serious problem and very few options. You *had* to get at least one engine re-started. Reflecting back to

▲ This photograph of aircraft parked on Area 51's north ramp was taken in late 1963. The line-up consists of seven single-seat A-12s, the Titanium Goose and, at the far end, the first two YF-12A interceptors. (Lockheed Martin)

> those days, we always got at least one turning and burning again. The most serious problem occurred when the TEB [tri-ethyl borane] probes started 'cooking', which caused a chemical residue to build up on the engine/afterburner-starting TEB probe, restricting the flow of TEB, which was required to re-ignite the engine and/or the afterburner. We had a lot of other mechanical and electronic system problems throughout the programme, but none as big as the inlet unstarts.

Virtually all these training sorties required a fuel top-off shortly after take off and the refuelling tracks, or anchors, were located within the Yuletide Special Rules Area (SRA), colloquially known as the Yuletide Special Operations Area (SOA), about 20 miles further north of the 'tunnel' (described in Chapter 4). For missions planned to the north, the refuelling track was orientated on a north-south axis, for flights to the east or west, there was an east-west track. If weather within the SOA wasn't conducive to air refuelling, the 'Oxcarters' used SAC anchors. A track located to the north of Lake Tahoe in western Nevada was used on several occasions for weather avoidance.

The A-12 was refuelled at an altitude of 30,000ft (4–6,000ft higher than the SR-71, because it was lighter and carried less fuel). On completion of the air-refuelling task, the A-12 would turn onto its outbound course and carry out a climb/dive manoeuvre referred to by Oxcart pilots as a 'Whifferdill' and designed to accelerate the aircraft rapidly through Mach 1 in order to reduce transonic drag and the associated increased fuel consumption.

The most frequently used track was that to the north. The main test-hop was known as the Wells Route. After air refuelling and completing the Whifferdill, the Oxcart headed directly for the small town of Wells, in northern Nevada. Climbing through 60,000ft, the pilot checked in with Salt Lake Center and informed them that he was above the SOA. Shortly after level-off at 75,000ft and the cruise-climb, the autopilot, coupled to the inertial navigation system (INS) rolled the aircraft into a left turn over the old mining village at Midas (about 50 miles north of Battle Mountain, Nevada); both Wells and Battle Mountain therefore received regular 'boomings'.

After passing over Area 51 on its return, the A-12 would complete a descending left turn to arrive back in the SOA for a let-down to base. A variation of this route extended beyond Area 51 before a wider left teardrop turn, followed by a deceleration into the SOA; this track enabled the aircraft to burn off more fuel and thereby achieve a much higher altitude. Both

routes ultimately terminated in the SOA, from which point the aircraft proceeded either under, over or through the tunnel before landing back at 'home plate'.

To provide project pilots with the opportunity to experience an extended fight with multiple 'hot-legs' for 'graduation' or final flight training, a route was also established to the west. After completing the first air refuelling and hot-leg, the pilot descended for another top-off near Hawaii, before completing a second and final hot-leg back to the SOA. For the 'graduation' flight, the Stan/Eval section often planned the tanker in the Hawaiian anchor to be out of position in order to give the new pilot a chance to exercise the lost tanker drill. During his first attempt at this route, Frank Murray recalls having 'great fun' experiencing a severe unstart at about Mach 2.4 at 60,000ft on the climb-out. 'It was so severe that it broke the sunshade visor on my helmet and managed to break off one of the canopy-mounted, over-the-shoulder cameras. Needless to say, I didn't graduate that day and returned to base a very weary and sobered young aviator!'

There were also routes to the east, one involving a single top-off followed by an easterly hot-leg of about 800 miles before turning back home for a run over the base. Another easterly route was named Super Continental. It included a second air refuelling near the east coast before turning back and recovering into Area 51. Some of these training routes included the use of the aircraft's camera and EW systems. Area 51 was equipped with a variety of threat simulators that could trigger a response from various pieces of avionics for the purpose of testing both the equipment and pilot.

The AT-12 only flew within the SOA since with its less powerful J57s it couldn't fly it above the positively controlled areas. It flew practically every Monday night to keep the pilots current in night flying and night air refuelling.

F-101 CHASE DUTIES

All A-12 flights from the Area were assigned an F-101 chase. During the early years, many sorties were documented by a camera operator (frequently a Lockheed employee, sitting in the back seat of the F-101 with a movie camera). Once the number of sorties increased, photo-chase flights declined, however. Typically for these missions, the chase pilot attended the A-12 pre-flight briefing and was ready to roll shortly after the Oxcart's brake release. After reaching a few thousand feet and 350kt, the A-12 usually came out of afterburner and the F-101 joined in close formation for its pilot to look over the Article for signs of leaks, loose panels, etc.

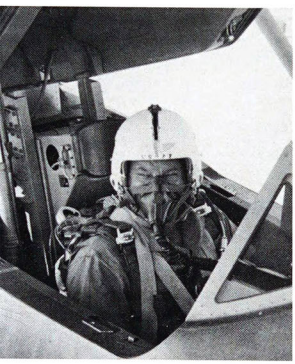
Chase then flew a loose route formation while the A-12 proceeded to the refuelling track designated for that mission. Through this period the flight generally remained below 24,000ft until north of the Wilson Creek–Coaldale airway. Once clear, the Oxcart climbed to the pre-contact refuelling altitude and, following a final 'nod of the boom' from the boom operator, the A-12 closed on the tanker and boom contact completed the radio silent rendezvous. The entire operation was carefully monitored by the chase pilot and once the Oxcart had topped off, cleared the tanker and accelerated away, the chase aircraft could ease into position and replenish its own tanks.

The A-12's fuel burned without a problem in the F-101's engines, but was not reliably re-ignited by the aircraft's spark plug ignition system if an engine re-light sequence became necessary – as chase pilot Dick Roussell discovered one day while demonstrating an air-start to a passenger! As a rule, chase stayed with the tanker until it departed; occasionally, A-12 test sorties called for a second AR, in which case chase would again be in position to monitor the situation. All the project pilots and several of the military staff officers at Area 51 were qualified

as chase pilots. In addition to the F-101, during the early years two F-104s provided by Lockheed were also used on high-speed chase duties to document A-12 flight tests.

Denny Sullivan recalls undertaking an early morning F-101 chase sortie:

> I chased Bill Park on a 6am routine non-refuelled test flight early on. As he accelerated, I got the '101 supersonic and stayed with him out to about Mach 1.3 or so. He then climbed and pulled away. But on this particular flight, while out at about 1.5 and climbing he suddenly came out of 'burner and turned back towards the Area. As I caught up with him, I asked 'What's the problem?' He answered, 'Aft bypass'. This was quite confusing, as the aft bypass doors on the engine didn't come into play at that speed. I later met him on the ground to talk over the flight. Turns out he aborted due to the need of a quick trip to the 'out-house'. It was either a case of abort the flight, or 'do it' in the pressure suit – it was probably one of the most expensive trips to a toilet on record.



▼ When Lou Schalk took Kelly Johnson for an orientation flight in Article 124, it was the first time the Skunk Works boss had ever flown supersonically. (Lockheed Martin)

Heavy maintenance on the F-101s was conducted at Hill AFB, Utah. Staff and Oxcart project pilots were rostered to position the chase aircraft to Hill and collect and return them back to Area 51 as dictated by the maintenance cycle. To prevent identification of individual Oxcart crewmembers and avoid awkward questions being asked, they were issued with blue NASA flying suits and jackets. All carried DoD identification and official orders, which authorized the bearer to undertake such flights in the event that they were challenged, but the pilot's names were not displayed on any of their flight gear. Instead, a four-digit identity number was stencilled onto white tape that was sown inside their collars. These same numbers were stamped onto their pressure suits and helmets, and replicated across the top shelf of each pilot's cubicle in the personal equipment room back at Area 51. The base ops staff at Hill AFB were soon used to seeing flight plans filed by blue-suited pilots declaring their destination to be one of the many airfields within the Nellis area – which was more or less correct.

KELLY GOES SUPERSONIC

A flight in the AT-12 was set up for Kelly Johnson to enable the aircraft's designer to get a feel for the platform's early performance. Lou Schalk was the 'instructor pilot' in the Titanium Goose and recalls:

> I took off, cleaned it up then 'gave it' to Kelly. He climbed the airplane, levelled off with the afterburners in and accelerated out to Mach 1.4. That was the first time he had ever been supersonic and he was delighted.
>
> The airplane behaved beautifully as we proceeded to take an INS trip to one of our checkpoints on the course. I rolled the airplane into a steep bank and there was the checkpoint – a city down in Utah, right on the money. I then contacted the tanker for a refuelling rendezvous – which at times could be a bit 'hit and miss'. He answered my call immediately and was right where he said he was. I picked him out, slid into position and the boom operator, who was red hot that day, plugged me off and we'd taken on 5,000lb of fuel and were gone again before we hardly knew what had happened.
>
> Maybe it wasn't a good idea to have such a good flight with the Boss, on whom

you were supposed to impress all the problems that you were having, but it was a beautiful flight and I'm sure glad he was there.

THE FIRST LOSS

As with most flight test programmes, success was not obtained without loss; the first A-12 crash occurred on 24 May 1963. At the time, the A-12 was experiencing problems with its engine fuel controls during acceleration and cruise. Ken Collins was scheduled to fly aircraft 60-6926, Article 123 for a series of subsonic engine test runs. He takes up the story:

Jack Weeks was scheduled as my F-101 chase pilot. Take-off and initial cruise was routine. I made the planned right turn to 180° and climbed to 27,000ft to stay out of the building cloud formations. During these missions the chase plane was to stay close enough to observe the engine nacelles and the afterburner areas, but far enough away to maintain safe flight.

The F-101 had a historical pitch-up problem if it got too slow in flight. As we continued south in the Wendover Danger Area (Northwest and Great Salt Lake) I entered an area of heavy cumulus cloud formations. My chase moved in to keep visual contact. Minutes later, Jack signalled that we were getting too slow for the F-101. The A-12 instruments (airspeed and altitude) were giving normal indications. Jack signalled that he could not stay with me. I waved him off; he cleared to my right and disappeared into the clouds.

I dedicated all my efforts to determining what the real problems were. I engaged the autopilot and reviewed all of the instruments and systems. There were no observable failures or abnormal indications. I then disengaged the autopilot, maintaining my planned airspeed and 30,000ft altitude. In a matter of seconds all hell broke out. Without any noticeable change of aircraft attitude or speed, the altimeter was rapidly 'unwinding', indicating a rapid loss of altitude, and the airspeed indicator was also 'unwinding', displaying a rapid loss of airspeed. In the heavy clouds, with no visual references and with what felt like a solid platform under me, I advanced the throttles, attempting to stop the indicated loss of airspeed, but with no obvious results. At this point I could not assume that any of my flight or engine instruments were providing correct data, and I was right. Without any warning the A-12 pitched up and went into a flat inverted spin.

Realizing that I had no effective controls and that the aircraft was unrecoverable from this flat inverted spin and that I had no true indication of my actual altitude, it was time to eject. I could have been much lower and over higher mountains, which would put me dangerously close to the ground or hilltops. I closed my helmet visor, grabbed the ejection 'D' ring between my legs, firmly pushed my head against the ejection seat headrest and pulled. The canopy instantly flew off, the boot stirrups snapped back into the seat retainers locking my feet securely for the ejection, and the rocket charge fired, shooting me down and away from the aircraft. The man/seat separator worked great. Shortly after separating from the seat my 'chute opened. I looked up to confirm that I did indeed have a good 'chute (this was my first ejection), then looked down at the ground to get a general idea of the terrain where I would land.

At that moment the 'chute broke away, separating from my parachute harness. I

▲ Serial 60-6926, Article 123, over Sudan Crater. It was the first Oxcart lost, crashing on 24 May 1963 after just 79 flights for 135.3 hours. Its CIA pilot Ken Collins ejected and escaped safely. (Lockheed Martin)

knew that my luck had just run out! There was momentarily a quieting sensation, a pause in my life. Just as suddenly, this beautiful 35ft canopy blossomed quickly, slowing my descent (the A-12 parachute system consisted of two elements, the first, a smaller drogue 'chute, deployed shortly after ejection and seat separation, its primary purpose being to slowly decelerate the pilot when ejecting at high speed and altitude. The main 'chute was of greater diameter than usual to compensate for the extra weight of the pressure suit. If the main deployed at high altitude and excessive speed, the pilot would be killed by the deceleration forces).

When I ejected, I did not know what my altitude was. After ejection I was just happy that I had a parachute and was out of the clouds. I had separated safely from the aircraft. When descending through 15,000ft, the drogue 'chute is programmed to separate and the main chute is scheduled to deploy. At that moment I truly thought that my parachute was gone.

During my descent, I saw the A-12 spiralling toward the ground and then a large column of black smoke and flames billowed from behind a hill. I had time to look around. I saw a road miles to the right and a lot of rough terrain covered with rocks and sage. As I got closer to the ground, I assumed the parachute landing position, with feet together and knees bent. I hit the ground and rolled on my right side into a standing position. I immediately released the riser safety clips and collapsed the 'chute.

You keep the parachute canopy for survival. I was in the middle of a hilly desert, with little prospect of being rescued soon. My chase plane (Jack Weeks) did not know where I was and because of the program classification, we did not maintain radio contact with base operations. I began collecting all my flight checklist pages, which broke loose during the ejection, together with any other aircraft items lying around. Much to my amazement, I saw a pickup truck bouncing across the rocks coming toward me with three men in the cab. When they stopped, I saw that they had my aircraft cockpit canopy in the truck bed. They asked me if I wanted a ride.

They said they would take me over to my airplane. I told them it was an F-105 fighter with a nuclear weapon on board. They got very nervous and said that if you're going with us get in quick, because they weren't staying around. There were four of us in the truck cab. I asked them to drop me off at the nearest Highway Patrol Office, which was in Wendover, Utah. I thanked them and that was the last I saw of them. I made my 'secret' phone call. The base sent a Lockheed Constellation loaded with security people and aircraft engineers in less than two hours. Kelly Johnson's jet arrived behind the 'Connie' to pick me up. Our flight surgeon and I flew directly to Albuquerque, New Mexico, to the Lovelace Clinic, for my physical check-up.

An intense accident investigation was conducted. I submitted to sodium pentothal

to confirm all my statements relating to the flight and the accident. The person who solved the true technical causes of the accident (inadequate pitot tube design had caused the air data computer to fail, an issue solved when the Rosemont Probe was introduced) was Norm Nelson, a dedicated government engineer and a fine, caring man, who later became vice president of the Skunk Works. As always, the initial belief is that there was pilot error, but fortunately the real causes of the accident was discovered and corrected.

Ten years after the accident, I received a package in the mail. Unwrapping it, I found a shadow-box frame with the 'D' ring mounted inside with the inscription to Ken Collins 'A Friend In Need'. It was my ejection 'D' ring from the A-12 and was sent to me by Keith Beswick, a Lockheed engineer on the Oxcart programme.

The wreckage of Article 123 was recovered in two days and persons at the scene were identified and requested to sign secrecy agreements; interestingly, the press cover story describing the accident as having occurred to an F-105 still remains listed this way on official records. The fact that the Oxcart was on a 'low' altitude sortie and that Ken was therefore not wearing his 'moon suit' gave further credence to the story.

In an ironic twist of fate, sometime after the loss of Article 123, an F-105 from Nellis *was* lost and members of Oxcart were involved in the search for the crash site. Frank Murray recalls:

Earlier in the day, four of the big Republic aircraft had taken off for a sortie in the Pahrump Valley area, west of Spring Mountains, near Las Vegas. After some in-trail formation aerobatics, the flight was minus number four.

The command post at Area 51 ordered both the base helicopter and Cessna 210 to help in the search. One of the flight surgeons, Roger Anderson and I, got airborne in the Cessna and set up a search pattern in the southern half of the valley 1,000ft above ground level on an east-west track. We soon located the crash site near a small lake adjoining the property of one of the brothels in the area, known as Ash Meadows Ranch. From the air, it appeared that the F-105 had impacted the ground, wings level in a slight dive. Marks on the ground were consistent with where first the drop tanks and then the tailpipe contacted before breaking up.

The brothel provided a small dirt runway, graded out, to allow its customers the option of air travel into the facility. Our party, attired in Air Force flight gear, landed and taxied to the main building where we were greeted by a gent. We explained that we were part of a search party and that we'd located a crash site and requested transport to check for possible survivors. He was happy to oblige and we were driven the few miles in the Ranch van and upon reaching the site the flight surgeon confirmed that the pilot had perished in the accident.

At about this time a chopper from Indian Springs arrived at the site and I provided the crew with a brief written report and returned to Ash Meadows. By now it was lunchtime and the madam had got the cook to rustle up lunch. During the course of a rather guarded but polite conversation with the madam, my aviation curiosity got the better of me and I asked her what was the largest aircraft ever to use the landing strip; she replied that light twins were regular visitors, but the largest was an Army C-7A Caribou packed full with GIs from an Army base in California. 'Mind you,' she added mischievously, 'they weren't looking for downed airplanes!' After lunch the three of us said our goodbyes and departed for life back at our own 'Ranch'.

As a final footnote to Ash Meadows Ranch, one of the 'lovelies' discovered that a

resident, who never actually 'indulged' himself, seemed to have a rather questionable background: further suspicions prompted the madam to notify the FBI. Slip Slater recalls being subsequently briefed by Nick Zubon, the Area 51 resident Agency chief of security, and it turned out that the individual in question turned out to be a ship's radio operator from an Eastern Bloc country. Following a raid on his room, an array of hi-tech communications equipment was discovered! It spelled the end of his days in espionage, but to date, no one actually seems to know who he was or what subsequently happened to him.

DESIGN SPEED – AT LAST!

On 24 June 1963, Kelly noted, 'During this month we have tried to pick up in our airspeed/altitude profile. Have not gotten much, due to voluntary grounding during #123 investigation and terrific troubles with Ham Standard spike control.'

Regulation of airflow within the air induction system was critical to the Oxcart achieving its design cruise speed of Mach 3.2. To achieve this, the inlet spike's aft-movement schedule had to be programmed very accurately as speed increased; the same accuracy applied to the position of various bypass doors. Once the fine-tuned control of the high-speed inlet/drag equation had been achieved, it was reasonably anticipated that fuel consumption would reduce significantly and the aircraft hit the design numbers. A couple of weeks later, Kelly wrote, 'Having difficulty in getting aircraft to speed, because of inlet problems. Do not know whether it is an aircraft, engine, or inlet control problem.'

Finally, on 20 July 1963, Article 121 reached Mach 3.0. However, while flying the same aircraft on a second attempt, Lou Schalk experienced what he described as perhaps the most 'thrilling' flight of his test flight career.

> I was approaching Wendover, Utah, from the south and the aircraft was accelerating like it had never done before. It was apparent that I would be at Mach 3 before I left Utah (well before reaching the turn point short of the Canadian border), so I throttled back and started my turn early. Emerging from the turn, I pushed the throttles to full 'burner and continued to climb. I got so far behind the aircraft that I didn't notice that the fuel flow fell off slightly, which led to a loss in rpm on one engine. The next thing I knew, I had an unstart, whereupon I attempted to open the bypass doors to break the unstart, but that action didn't seem to help. Then the other inlet unstarted and so it went on with terrific oscillations continuing, one after another.
>
> I made a single radio transmission saying that I was in real trouble. I thought I ought to bail out, but stayed with the aircraft because it still seemed to be in one piece and still flying, although these violent oscillations continued all the way down to Mach 1.4. I then realised that I'd left the right engine in 'burner and that the left engine had flamed out. I was holding tremendous rudder pressure with one leg in an attempt to fly straight without even trimming out some of that pressure with the rudder trim switch. When I finally came out of afterburner it was much easier to handle, so I restarted the flamed-out engine and headed back to base.
>
> At the debriefing I learned that the engineers had decided at their Monday morning maintenance planning briefing that the slow acceleration and high fuel consumption could be due to the bypass doors leaking air after they had closed. They therefore decided to 'bolt' them closed, but no one had told me about this decision and that's why the aircraft had taken off on me like 'a scorched dog'. It then also

became clear why I couldn't break the unstart and why, when I tried to switch the bypass doors open, nothing happened to change the inlet airflow. After the lesson in lack of communication between engineers and pilots, I attended all the Monday morning maintenance planning briefings!

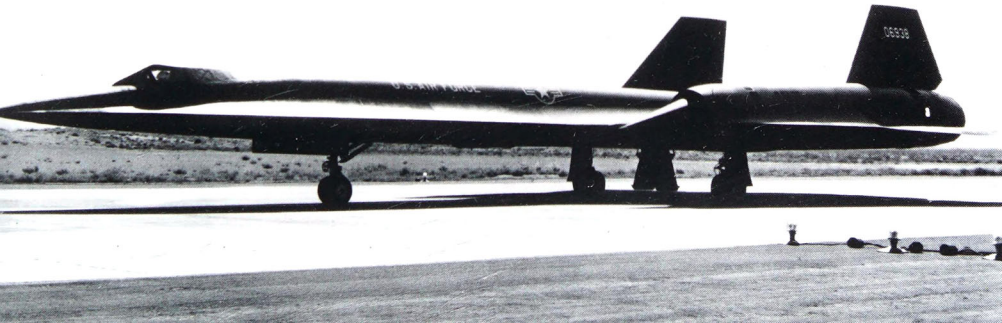
Kelly noted in his diary: 'On the second flight, we blew an engine at design speed. It was very difficult to slow down and it rattled Lou Schalk around for three minutes. The aircraft stability augmentation system did precisely as I asked it to do three years ago and no high structural loads were obtained.'

These envelope expansion flights from Area 51 trod a well-worn path across the emptiness of Nevada, northward over Wendover, Utah, high across southern Idaho and then turned east or west along a smooth 180° arc just short of the Canadian border, before heading back south toward Arizona or California and finally back down into the 'roost', north of Las Vegas. Sonic booms were heard all over the western United States and complaints were conveniently shifted toward the Arizona Air National Guard Fighters at Phoenix, then onward to the naval aviators at Fallon, Nevada and then onward still, towards any flying outfit capable of booming, this convenient shifting of blame being ignored by the 'Oxcarters' and Federal Aviation Administration (FAA) controllers who knew the truth. During the return leg to Las Vegas, the A-12 would reach its test-point objectives above 72,000ft, an altitude that would also allow the pilot to make a steep but safe recovery back to the 'Ranch' in the event of an inflight emergency.

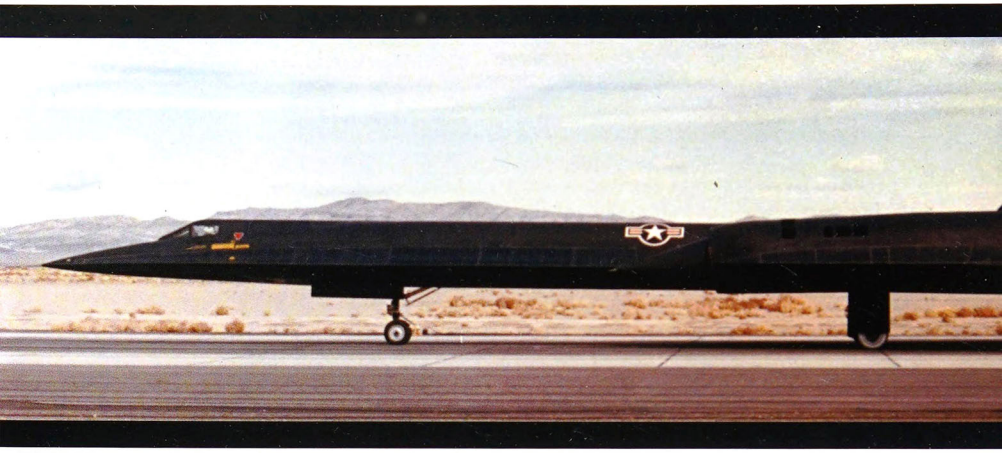
The cockpit workload during A-12 test flying was extremely high, partly because the turbine inlet temperature (TIT) tended to wander. This variation needed close monitoring if engine damage was to be avoided. At 7,300rpm, unstable temperatures caused thrust variations, so two toggle switches were introduced to allow the pilot to 'trim' the fuel flow in small increments, without having to adjust the throttle positions, to keep turbine temperatures within operable limits. Two rotating wafer switches controlled the inlet spike position (forward and aft), while a third set varied the bypass door positions (open to closed). The task of flying the aircraft while manually operating those six control switches and determining the optimum inlet schedule of door and spike positions created a situation where the pilot was saturated with switch movement activity during acceleration to high Mach.

It was soon realized that it would be near impossible to fly the aircraft during unstable situations without the stability augmentation system (SAS) operating. This gyro-stabilized system, coupled into the autopilot, made life in the cockpit more tolerable, despite the disheartening effect it had of causing more than a third of the total fuel load to be used during the acceleration to full speed due to poor inlet scheduling. The slow initial progression 'to full speed' was the result of a trial and error positioning of door and spike inlet schedules.

During these early tests, speed was gently increased by one tenth of a Mach number before the next spike progression increment was selected. If all worked well, that day's work was



▼ Article 132 in its all-black paint scheme with national insignia and US Air Force titles on the fuselage, despite it being a CIA aircraft. (Lockheed Martin)



analysed in the labs and incorporated into the schedule. More often, however, the spike position would not match the inlet duct requirements and a hard unstart (the violent, sudden expulsion of the normal shock wave from the internal throat of the inlet to its outside) would cause a harsh yaw movement, which swung the nose sharply in the direction of the unstarted inlet, snapping the pilot's head quickly to one side in the process.

To break a sustained unstart and recapture the disturbed inlet shock wave, the pilot would have to open the bypass doors on the unstarted side and move the spike fully forward, before slowly returning them to the smooth-flowing, but less efficient position they had occupied prior to the disturbance. Incessant problems in the air induction system caused Lockheed's propulsion engineers to change the inlet geometry and trim schedules. In addition, the manual trim schedule was speeded up to allow the aircraft to be accelerated more quickly and save fuel during the climb to high altitude.

During that first year of development testing, the inlet control schedule was changed often, and on many flights the two inlets never seemed to work together. Project pilot Walt Ray (wearing a Beatles' wig), after returning from a night training sortie filled with many unstarts, joked to the debriefing team at Area 51, 'Man, that was a hairy flight!' Unstarts came to be expected on almost all the early A-12 flights.

On 8 November 1963, Kelly was more upbeat when he noted, 'Today we flew the mice installation, to change the subsonic diffusion angles in the duct. This change corrected the roughness encountered at Mach 2.4 up, and it is the first major improvement in the duct. However, on 19 December he wrote, 'Still having trouble with Hamilton Standard on inlet controls.' (The 'mice' were protuberances installed in the air inlet, where they modified airflow distribution.)

Painful though it was, progress was moving in the right direction and on 3 February 1964 Kelly wrote, 'Jim Eastham took #121 to Mach 3.3, with 15 minutes at Mach 3.2 or above. It singed our old tank-sealing compound, but was a very good flight. I am building up a variable bypass area at the face of the engine and have re-faired the upper outboard quadrant to get improved airflow distribution at high Mach number. At about this time, we flew #122 for 53 minutes at M2.65 or above.' In all, it took 66 flights to push the speed envelope out from a marginal Mach 2.2 to Mach 3.2.

◀ Article 125 was lost on 5 January 1967 during a training/test flight. Its CIA pilot, Walt Ray was killed when he failed to separate from his seat after ejecting. (Lockheed Martin)

◀ Bill Skliar took part in the A-12 flight test programme but returned to the US Air Force before the aircraft was deployed operationally, where he continued his flight test career on the SR-71. (Lockheed Martin)

MORE TESTING, MORE LOSSES

On 9 July 1964, after a ground roll of 7,400ft and on reaching 210kt, Bill Park was airborne from Area 51 at 08:20 local time in Article 133. The test card called for a maximum afterburner climb at Mach 2.8 to 78,000ft on the Copper Bravo route. He was chased through the lower Mach numbers by Col Holbury and Capt Roussell flying an F-101. At the northern end of his route, Park initiated a left turn onto the southbound leg, but suffered a left engine unstart and simultaneously lost the SAS's 'A-channel', which controlled yaw. Recovering from the unstart, Park accelerated back to Mach 2.8 and headed for home with both engines functioning smoothly, but the 'A' yaw SAS still down.

Having decelerated and descended to 28,000ft in the vicinity of Area 51, he was re-joined by the chase aircraft. Adopting a high approach profile, Park was at 16,000ft downwind and 12,000ft base leg before rolling right onto final. He maintained 200kt and continued his descent for about a mile, but when the aircraft was at about 500ft it began a smooth, steady roll to the left. Park applied full right elevon to counteract the roll and increased power, but 133 continued its left roll. At about 45° and 200ft Park ejected. The aircraft continued its left roll, struck the ground inverted and exploded in a spectacular fireball. After just one quick swing under the rapidly deployed canopy of his parachute, Park's feet hit the overrun to runway 32. He'd had a very narrow escape but was uninjured.

The accident investigation was initially hampered since the data stored in the flight recorder was lost when it was destroyed in the crash. But the team's diligence was able to establish that the accident was caused by the outboard elevon servo valve becoming stuck in the partially open position, causing the right outboard elevon to gradually move to fully down. This imparted more left roll to the aircraft than could be corrected by the pilot.

The valve had failed due to warping through a temperature shock condition induced during the rapid change of flight condition (the fast descent from high to low altitude), and metal particles within the servo valve that probably accumulated during its manufacture. As a result, design of the valve was changed and the servo assemblies subjected to a temperature shock environment to reduce the possibility of binding. In addition, the flight recorder system was replaced by a more modern robust system capable of withstanding crash damage. Finally, the board recommended that in future all A-12 take-offs and landings from Area 51 be filmed

– a recommendation that proved particularly useful just five months later.

The accident investigation board examining the loss of 133 gave a useful insight into the intensity of Oxcart test flying at the time. It recorded that at the time of the accident, Bill Park had accumulated 148 hours on type, 39 of them in the last six months, and that he'd completed 6 hours 15 minutes in the last 30 days in 11 flights (thus the average flight time during the envelope expansion phase of testing was just 34 minutes).

August 1964 was yet another busy month for the Skunk Works boss:

> We are going forward with maximum energy to provide four operational airplanes with limited capability to fly over Cuba on Nov. 5th. We have been told by the Soviets that immediately after the [US presidential] election they intend to shoot down every U-2, which we are operating at a rate of 18 sorties per month. Should this be done, we would be unable to find out whether they put missiles back in; so the A-12 is vital for this purpose [this became Project Skylark]... Flew airplane #129 with J engines [Johnson's nomenclature for uprated engines that increased available thrust from 29,500 to 32,500lb] and afterburners. It has the best acceleration of any to date and it looks quite promising. However, we lost one engine, due to FOD [foreign object damage], from some source as yet underdetermined.

September 1964 was the month that Kelly Johnson was recognized for the enormous contribution he'd made to aeronautical engineering through the Oxcart programme, despite the fact that many of its details would remain classified for decades to come. On the 11th he received the Theodor Von Karman Trophy from the Air Force Association for the 'A-11'. Three days later he received the Presidential Medal of Freedom from President Johnson at the White House. On 24 September he was back at the White House, this time to receive the Collier Trophy. Two days later, it was the turn of his A-12 test pilots when Lou Schalk (who had by this time left Lockheed), Bill Park, Jim Eastham and Bob Gilliland were awarded outstanding achievement awards for 1963 from the Society of Experimental Test Pilots.

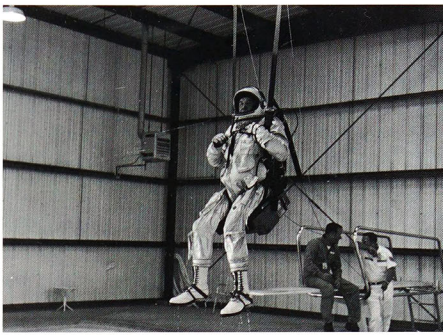
In December 1964, Kelly noted that: 'By using 450kt vs 400kt EAS [equivalent airspeed] in climb, we have overcome transonic problems. We are trying to get #129 in shape for a long flight, but are having continual engine problems on compressor discs, blade cracking, etc; so not flying much.'

Pneumatic pressure gauges were installed on the inlet systems to sense pressure variations of as little as ¼psi. Inlet spike position was based on a schedule derived from their readings. But it had become increasingly apparent that these pneumatic instruments were not sensitive enough for the job of accurately scheduling the spikes. Therefore on 18 March 1965, Kelly wrote in his diary, 'On this date I sent Hamilton Standard a letter saying that we could not continue trying to develop the AIC-10 inlet control. We have spent $17,000,000 on the thing to this point, but it just will not do the job and is totally unpredictable.'

Aircraft were coming off the production line with the pneumatic system installed, but Kelly decided that it should be replaced by an electronically controlled system manufactured by the Garrett Corporation, even though thermodynamic considerations had minimized the number of electrical systems used in the A-12. Initially it required far more maintenance per flight hour than the pneumatic system, but its inflight performance was far superior to the old equipment. Despite the added cost, the electrical system was retrofitted to all aircraft already delivered and incorporated in the A-12s being produced at Burbank from aircraft number 9 onwards. On 14 May 1965, Kelly noted, 'Hamilton Standard withdrawing a number of their people. Our long battle with them is coming to a sorry end.'

Before the new spike control system was flight trialled, many electromagnetic induction

(EMI) tests were carried out on the ground to ensure non-interfering operations. It was thought 'all was well' until a radio check made the inlet spikes retract! Back to the drawing board and more tests. When Bill Park briefed the other pilots about the new system, he added that unstarts would soon be almost a thing of the past. None believed him, but the new system immediately began to prove its worth and the number of unstarts reduced dramatically. Fuel consumption also decreased significantly due to the tighter inlet spike and door scheduling. On 21 June 1965, after a long, hard test career, 121 was transported back to Burbank to be brought up to date with a series of modifications.



▲ Ken Collins uses Area 51's heated indoor pool during water survival equipment training for a simulated 'feet-wet' parachute landing. (CIA)

SCOTCH MIST

Talk of possible operational deployments abroad spurred preparations to ready the aircraft. In September 1965, it was decided to flight test a windshield rain-clearing system, developed to enable the pilot to maintain forward visual contact with the ground during descent in heavy rain. The project, codenamed Scotch Mist, would also examine the flight characteristics of an Oxcart operating at sea level – the A-12 had only ever been flown routinely out of Area 51, which was well above sea level.

It was decided that the tests would be conducted from McCoy AFB, near Orlando, Florida, since its meteorological conditions were similar to those expected at Kadena Air Base (AB) on the Japanese island of Okinawa – a possible deployment destination. An A-12, with support provided by an F-101 and Area 51's C-130, was sent to Florida, along with pilot Walt Ray.

McCoy was a joint-use Air Force/civil airport, and at the time few people directly outside the Oxcart programme had seen the A-12, as Slip Slater relates:

> When the bird rolled out for take-off, no one had ever seen a 'Blackbird' and you could almost see the airliners tip as the passengers rushed to the side windows to get a peek! Another interesting event occurred on the first few attempts to get the machine airborne. Walt would get to the end of the runway for take-off and when he came back on the throttle, the engine would quit! Well, that brought a rash of P&W, Lockheed and United Aircraft [fuel control] guys out from Connecticut to identify and rectify the problem. They discovered that the T-2 sensor in the engine nacelle had to be repositioned – that cured it.

The rain clearance system was tested by flying the aircraft through local showers. A switch activated in the cockpit caused a chemical water wetting agent to be sprayed from nozzles located along the 'barracuda blade' (situated at the apex of the windscreen) to dissipate raindrops. To date, records commenting on the effectiveness or otherwise of the system remain elusive, however, Frank Murray recalls using the system once 'in anger', having returned to Kadena after completing an operational mission.

> It was 'raining like a dog', Denny Sullivan was out at the mobile and I recall thinking, 'Here's a great chance to try the vaunted rain-clear system'. I told Denny, but when I activated the switch, the stuff came out as white as milk and I couldn't see a thing through the windshield. Denny helped me by saying 'Okay, get the 'chute, get the

'chute!' He was saying for me to deploy the drag-chute… I could only see the sides of the runway. So much for the rain clear-system! Turns out the fluid had to be changed regularly and not kept indefinitely, since it coagulated from the heat accumulated during cruise.

ARTICLE 126 IS LOST

On 28 December 1965, Mele taxied Article 126 out for a functional check flight (FCF) and lit the 'burners for what he thought would be a straightforward sortie. As he reached rotate speed, he gently applied back pressure to the stick for rotation to lift-off attitude. But instead of 126's nose rising smoothly, it yawed viciously to one side, and Mele stood on the rudder pedals to correct the yaw. Instead of rectifying the yaw, the rudder input made 126 pitch-up.

The rash of instinctive responses that followed resulted in a series of counter-movements opposite to those an experienced pilot would expect. It was, indeed, a pilot's nightmare. When the aircraft became airborne, it pulled itself toward the ground and back-stick pressure caused another hard yaw movement that could not be corrected by counter-rudder pressure without an increasingly sharp pitch movement. In the midst of this wild pitching and yawing, Mele pulled the D-ring between his legs and at an altitude of not more than 100ft he blasted free of his unmanageable 'bronco', riding his parachute to the only safe landing possible. Narrowly missing the flaming pyre that billowed up from another lost A-12, Mele landed safely after just six seconds of flight. It was all filmed by Keith Beswick, one of Lockheed's flight test engineers (this wouldn't be the only loss of a Blackbird that Beswick would film).

The subsequent accident board established that the SAS had been cross-wired. The pitch SAS had been connected to the Yaw SAS actuators and vice versa. With the SAS ineffective until rotation, Mele had no possible opportunity to identify the potential problem until the gyro-sensed SAS reacted to rotation as if it were a yaw input at the most critical moment of flight – lift-off. Through a series of tests in the new SR-71 simulator then being installed at Beale AFB, it was determined that none of the trained A-12 pilots who repeatedly tried to fly out of such a situation could have saved 126. Indeed, it was considered 'miraculous' for Mele to have been able to escape with his life. The SAS connectors were subsequently made error proof.

OXCART DESCRIBED

Viewed in the context of the best frontline fighters of the day, the early Century Series jets, including the F-100 Super Sabre and F-101 Voodoo, Oxcart was a giant leap into the technically unknown, doubling and trebling their altitude and speed envelopes, respectively. It would cruise in afterburner at Mach 3.2, possess an unrefuelled range of 4,000nm and have an end-of-cruise-climb ceiling of between 84,500 and 97,600ft.

Above 80,000ft the ambient air temperature is -56°C and atmospheric pressure just 0.4psi. However, cruising at one mile every two seconds, the A-12's airframe temperatures soared to between 245 and 565°C. Accordingly, 85 per cent of the aircraft's structural weight was titanium to cope with the extreme temperature environment.

The Pratt & Whitney J58 engines each initially produced 29,500lb of thrust (increased to 32,500lb in the 'J' engines), and required 100,000cuft of air per second at design speed. Such an awesome performance envelope ensured that virtually everything on the aircraft had to be invented and built from scratch.

At Mach 3.2, the TIT exceeded 1,100°C, forcing development of a unique fuel, known originally as PF-1 and with a much higher ignition temperature than JP-4. Standard ignition systems were incapable of producing the required heat for PF-1's combustion and a chemical ignition system (CIS) was therefore developed using a highly volatile pyrophoric fluid known as tri-ethyl borane (TEB); it was extremely flash sensitive when oxidised.

A small TEB tank on the aircraft enabled engine and afterburner start on the ground and aloft. The tank was pressurized with gaseous nitrogen to ensure the system remained inert. Liquid nitrogen carried in three dewar flasks also provided a positive 'head' of gaseous nitrogen in the fuel tanks – this insured against vapour ignition as the wet (non-lined) fuel tanks depleted and prevented them from crushing as the aircraft descended into denser air to land or refuel.

The PF-1 fuel was extremely caustic, eroding traditional fuel bladders and lines. Therefore the KC-135 tankers carrying Oxcart fuel required special fuel tanks and lines separate from those needed for their own JP-4. To accommodate the PF-1, the liners in the KC-135's forward body, centre wing, aft body, and upper deck fuel tanks, along with the air-refuelling manifold, were replaced with a special ceramic material impervious to PF-1; this expensive modification added considerable weight to the aircraft.

In addition, compared to regular AR, rendezvous and refuelling procedures differed dramatically for the A-12 'receiver', the tankers requiring additional navigation and communication equipment to suit. During 1961–62 the CIA funded the modification of an initial cadre of KC-135s (determined by the minimum number needed to sustain maximum flight operations for ten Oxcarts). SAC identified 21 KC-135As for modification, all low-time airframes with good maintenance records.

Originally the A-12 refuelling mission was to be assigned to the 924th Air Refueling Squadron (AREFS), 93rd BW at Castle AFB, which was located relatively close to Area 51. However, with the subsequent development of the SR-71, SAC successfully argued that the SR-71s and their dedicated KC-135s should be co-located at Beale AFB, so the refuelling mission went to the 903rd AREFS, 4126th Strategic Aerospace Wing (later re-designated the 456th SAW).

To eliminate the caustic effects of PF-1, the Shell Oil Company, Ashland Oil Company, and Monsanto Chemical Company developed a low vapour pressure, less caustic replacement fuel known as JP-7. This eliminated the need for ceramic linings, which were later removed from the modified KC-135s and replaced by the standard rubber liners. The KC-135 tankers could burn JP-7, although not as a primary fuel, and following an 'air flush' of the JP-7, the tanker could then carry JP-4 in all its tanks as well as offload it to any receiver.

During their first four years of operations, the A-12 and SR-71 tankers retained their KC-135A designation. On 16 June 1966, however, Aeronautical Systems Division (ASD) specified an *en masse* re-designation of the 21 dedicated KC-135A aircraft to KC-135Q, although the change did not take place until the latter half of 1967; why the series suffix 'Q' was selected is unknown.

NAVIGATION EQUIPMENT

The Oxcart's primary navigation system was the YG8027A1 INS with an MA-1 compass as backup. An inflight magnetic tape data recorder stored time, geographic position and attitude information from the INS, together with pertinent information from the camera package. An AN/ARC-50 UHF and an AN/ARA-50 UHF-DF were used for security communication and generated range/bearing data for air refuelling rendezvous. In friendly airspace a modified

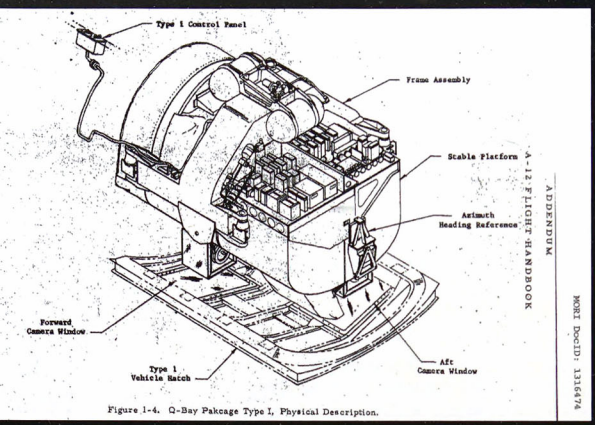
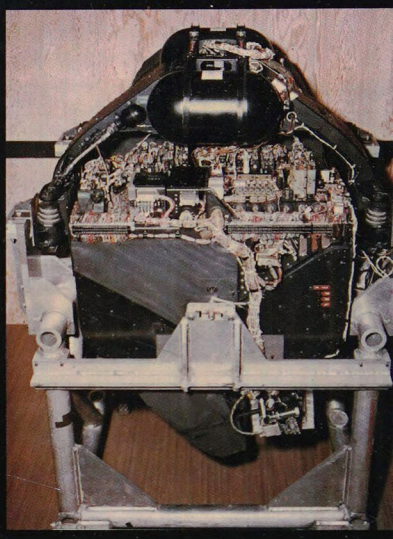


Figure 1-4. Q-Bay Pakcage Type I, Physical Description.

▲ Built specifically for the Oxcart programme, the Perkin-Elmer Type 1 camera used two scanning heads carried on a single stabilized platform. (A-12 Flight Handbook via Frank Murray)



▶ In the words of one senior intelligence officer, without the Perkin-Elmer Type 1 camera, the A-12 would 'just be burning expensive holes in the sky!' (CIA)

DF203 automatic direction finder (ADF) was used for 'homing', and an ARC Type 15F VHF omni-range (VOR) and AN/ARN-58 glide slope and marker were used as navigation and landing aids. An AN/APX-46 was provided for identification friend or foe (IFF) purposes.

MISSION SENSORS

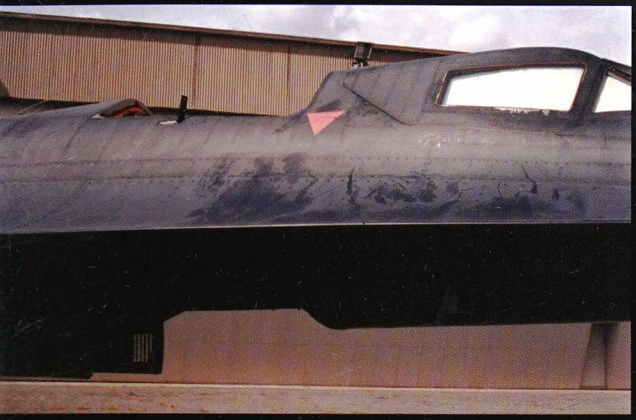
VIEWSCOPE

The Baird-Atomic 6642-1 periscope system enabled the pilot to see the ground below. It had two settings. Wide-angle provided a conical field of view that could be enlarged to 131°. With this setting selected and normal side vision through the cockpit windows, the pilot could scan from horizon to horizon forward of nadir (a point on the earth's surface directly below the aircraft) and also had a narrow field of view providing coverage of 57° forward of nadir.

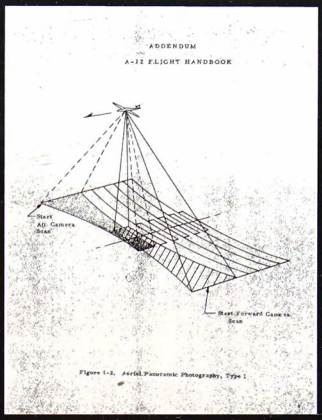
CAMERAS

Three different cameras were developed for the Oxcart programme. Eastman Kodak produced the Type II, a high-convergent stereo unit using a 21in. lens focused onto 8in. film. It produced pairs of images covering a swathe 30 miles either side of the Oxcart's track, with approximately 30 per cent stereo overlap. Film capacity was 8,400ft and the fine grain film provided a ground resolution of 17in. at nadir.

Hycon's A-12 camera was developed by Dr James Baker and known as the Type-IV. It was a development of the Type B camera used so successfully in Aquatone. Its 48in. f/5.5 lens focused images onto 9.5in.-wide, fine grain film and, like its predecessor, could provide seven



▲ The A-12's camera system was located in a pressurized area known as the Q-bay, located behind the cockpit. This same area accommodated the raised second cockpit in the AT-12 trainer. (Jim Goodall collection)



▲ The Type 1's forward and aft scanning heads provided stereo overlap at nadir, before each scanned out to the left and right, 67° either side of the Oxcart's track. (A-12 Flight Handbook via Frank Murray)

frames, covering a swathe 41 miles wide with a stereo overlap of 19 miles. Its capacity was 12,000ft and the package provided a ground resolution at nadir of just 8in.

Only the Perkin-Elmer Type 1 aerial panoramic camera system was used during operation *Black Shield* missions, however. It gathered its images transverse to the A-12's line of flight.

The camera package consisted of two major assemblies, a stable platform and a supporting frame. The former contained the camera systems, associated subsystems and a stabilization system. The stabilized platform was gimbal supported at its centre of gravity via a rod fixed to the frame assembly. This was installed directly into the A-12's Q-bay on four isolation shock mounts.

The platform operated in either caged or uncaged conditions. In the caged condition the platform was locked to the frame and therefore fixed with respect to the A-12. In the uncaged condition, the platform was freely suspended from the gimbal support rod and allowed to stabilize with respect to roll rate and pitch.

Forward and aft optical systems within a single camera package on the stable platform accomplished the photography. The forward system scanned the target area from 67° to the left of nadir to 21° to the right of nadir. The aft optical system scanned the target area from 21° to the left of nadir to 67° to the right of nadir. The camera package thereby provided 42° of stereo coverage directly below the aircraft, and a total swathe 134° wide (which from 80,000ft was 72 miles). The scan cycle time was 4.8 seconds and each frame was timed to produce a 30 per cent overlap. Ground resolution was 1ft at nadir and 3ft, depending upon haze degradation, at the outer edges of the image – 36 miles left or right of the Oxcart's track.

The f/4.0 19in. lens gave a frame size of 27.6 × 6.3in. Transport of the 5,000ft of film for each camera was by a concentric supply and take-up system to ensure that film weight remained centralized, thereby minimizing potential changes in the aircraft's centre of gravity as the film advanced. Since inflight temperatures at the camera viewing port could vary between -40 and 290°C, an isothermal window provided a protective barrier between the

severe temperature gradients and the camera's film. This was sealed to the Type 1 camera and a pump used to create a vacuum between the camera base and the glass.

The entire camera assembly was lowered through a removable hatch into the Q-bay and the camera sought its targets through a high-quality quartz window that measured 22 × 23in. Problems encountered when bonding the window to its metal frame were eventually overcome during a three-year, $2-million programme that developed a unique fusing process using high frequency sound waves.

BIRDWATCHER

Birdwatcher was a monitoring system unique to the A-12. It employed a multiplexed High Frequency/Single Side Band (HF/SSB) radio system and was designed to telemeter signals concerning the operation/non-operation of various aircraft systems down to a specially equipped ground station. The frequencies selected for any particular mission were briefed and noted by the pilot on hand-cards; they were also annotated on the mission filmstrip, which was displayed to the pilot in the cockpit.

The system comprised two main elements, air and ground. The air element employed an antenna consisting of a tubular structure within the pitot/static system located at the front of the aircraft. A relatively short antenna, it was closely matched to the airframe's ground plane, effectively creating a much larger and fairly efficient antenna from the aircraft itself. Of Birdwatcher's 40 channels, 32 monitored individual aircraft systems; channel 54, for example, covered the starboard engine's exhaust gas temperature (EGT), channel 7 the starboard engine's fuel flow and channel 3 the aircraft's altitude.

If any pre-set parameters of the monitored systems were breached, Birdwatcher keyed and modulated the HF transmitter with a coded signal. This consisted of three consecutive half-second bursts, each separated by a five-second period of silence. During each of the half-second bursts, the aircraft's identity and the condition of each of the systems monitored was transmitted. These three bursts could be heard through the pilot's headphones as three chirps, leading to the name Birdwatcher.

The pilot had only limited control over the system. In the cockpit there were two switches labelled 'A' and 'B'. The 'A' code was usually used to signify to the ground station that the aircraft had reached a pre-designated point in the mission and was in a 'GO' condition, such as at the end of a successful air refuelling, or upon reaching

◀ An unidentified A-12 lines up on the Area 51 runway, closely followed by its F-101B chase aircraft. A second A-12 can just be seen undergoing pre-flight checks on the other side of the blast wall. (Lockheed Martin)

a predetermined distance to go (DTG) or turn point. The pilot generally activated the 'B' code to indicate that the aircraft had experienced an abort condition. The two buttons could also be used sequentially to indicate that something unusual had occurred. For example, 'B' followed by 'A' might be interpreted to mean that the article had an abort condition, but was not in an emergency situation.

Involuntary Birdwatcher codes were transmitted automatically when any one of a number of sensors tripped the encoder. It also transmitted a code when the Oxcart's electronic countermeasures (ECM) equipment was tested with the built-in-test (BIT) switch. A 'mute' switch inhibited all the A-12's radio emitters except Birdwatcher. It prevented accidental transmissions by TACAN, UHF radio, etc and the pilot was usually instructed to operate the switch by the mission filmstrip prior to entering denied territory.

Birdwatcher could also be interrogated by appropriately equipped ground stations. The command post (CP) could, if required, cause Birdwatcher to transmit a short burst of information that would only include the coded identification of the Oxcart, if no other sensors had already tripped. To the dismay of a couple of pilots, some of those monitoring the aircraft's progress from the ground station at Kadena occasionally interrogated the aircraft when it was over enemy territory.

The ground station for Birdwatcher at Area 51 was located just outside the entrance to the CP in the secure communications room, an area that no one was allowed access to without good reason. From here an operator monitored an oscillograph paper recorder that reacted to the Birdwatcher's 'chirping'. Lights were used to develop the oscillograph paper to a point where it was possible that the technician could place the paper on a readout cursor and see which sensor had tripped. He then activated a switch that illuminated an appropriate light on a light board located in the CP, alerting other officers as to the aircraft's status.

ELINT

The A-12 had an ELINT capability through equipment known as System 6. A wideband collection system, it comprised a miniaturizing wide-frequency receiver that monitored C, L, X and P-bands. These were split and recorded by two three-channel recorders working at 2¼in. per second. C and X-band information, together with capture time and left or right of track directional information, was channelled to one recorder, while the same data for L and P-bands was stored by the other unit.

ECM

Very little changed on Oxcart's ECM suite from the initial installation. All systems were activated by a single, three-position power switch labelled 'OFF', 'Standby' and 'ON'. There was also a BIT switch that activated a logic test to ensure each element worked correctly. These checks were undertaken by the pilot prior to entering denied territory; satisfactory completion of the checks caused the Birdwatcher to chirp, confirming to the ground station that the aircraft was about to penetrate hostile airspace. If the BIT check failed, it was mandatory for the pilot to abort the mission.

The only element of the system visible to the pilot was a series of five lights positioned above the view scope and enclosed in the cockpit glare shield. The outboard lights were marked 'DF'; the set inboard of these was marked 'LI' and the larger centre light was known as the 'JAM GREEN' or 'JAM RED' light. The DF lights illuminated when the ECM system detected a SAM target acquisition system tracking the Oxcart. If only one of these two lights was on it indicated the general direction of the tracking radar; if both were on, it meant the

SAM system was ahead or there were systems on both sides of the flight path. The LI lights illuminated when the SAM site's radar had gone into a high pulse repetition frequency (PRF) mode, usually indicating that the site had launched one or more missiles. Frank Murray recalls the usual sequence of events:

> When a SAM site was on you, the DF light or lights would come on and this started the Birdwatcher chirping. Then the LI light(s) would come on, indicating a missile launch. Then came the moment of truth! Sometime into the missile flight time the active parts of the ECM suite would activate and the JAM GREEN light would illuminate. This indicated to the pilot that the ECM system was working to counter the missile's guidance system. If, however, the JAM RED light illuminated, this indicated that the active elements of the system weren't working correctly, in which case the pilot had to depress and hold down a button marked 'JAM O'RIDE', located on the top-right portion of the flight control stick. This activated the noise-jammer part of the ECM suite. I have to say though, that I'm not aware of anyone in the programme having to use the 'JO' switch.

The various elements of the ECM suite were given cryptic names. 'Pin Peg' was a radar homing and warning receiver (RHAW) that monitored S and C-band frequencies to indicate the presence and approximate position of "Fan Song" target acquisition radars associated with the SA-2; if required, it could activate the jammer.

'Blue Dog II' was the hardware that provided the protective element of Oxcart's ECM suite. A large deception radar countermeasures system, it weighed in at 480lb, required a power input of 20kW and had an antenna gain greater than 79dBm. Using a technique known as range gate pull off, it deceived the SA-2's missile guidance system by generating false guidance commands.

Pin Peg and Blue Dog II were used in association with 'Big Blast' or 'Mad Moth'. The former covered S and C-bands, generating barrage and deceptive noise protection against SA-2s, while the latter provided protection in S and C-bands against SA-2s through angle deception.

CHAPTER 4

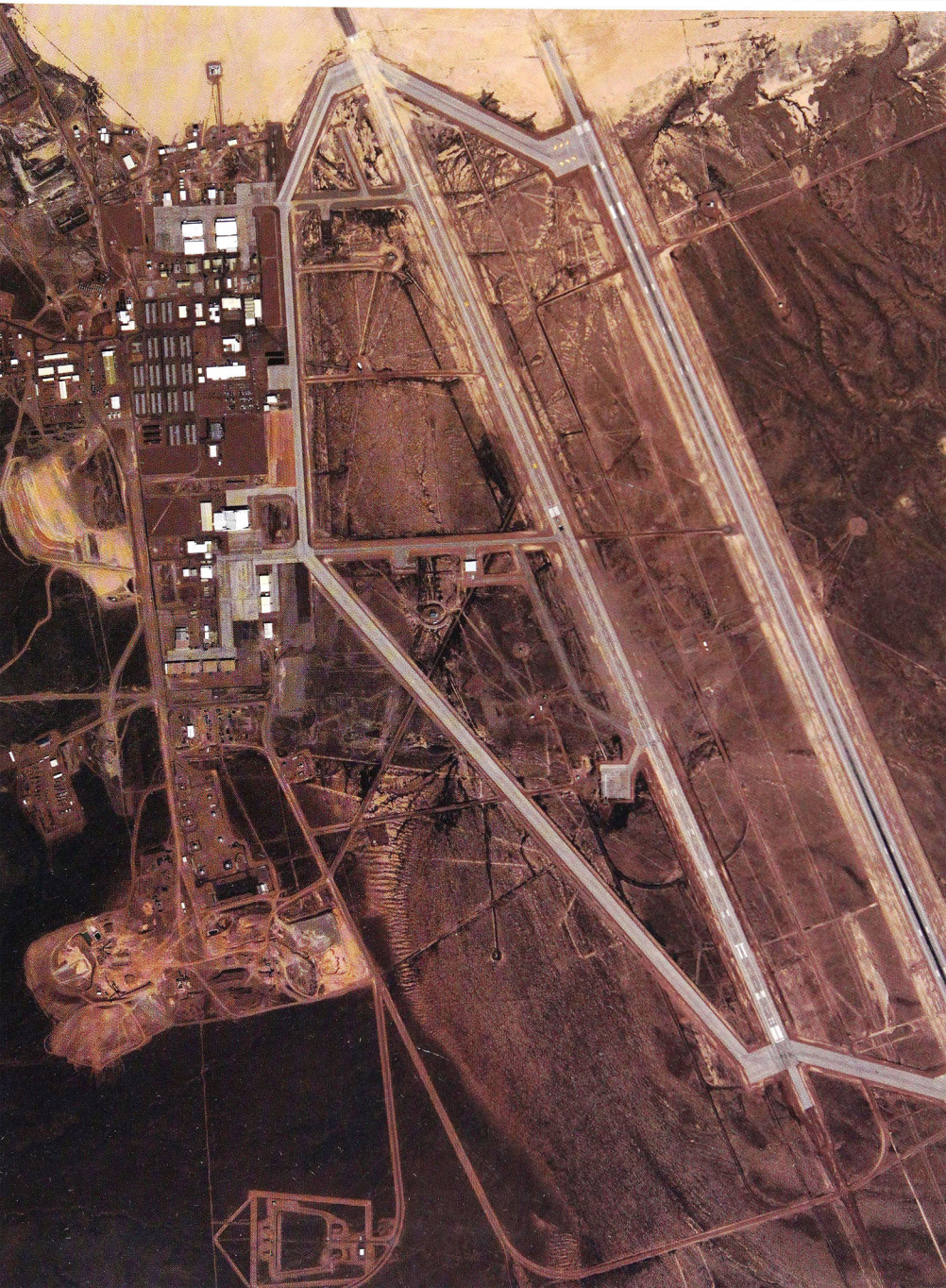
AREA 51

DEVELOPMENT

It was almost inevitable that Oxcart flight testing would be conducted from Groom Lake, the area in which Watertown had been established. When the U-2 programme moved out of Watertown, the base remained more or less unoccupied, but all that was about to change. Before the A-12 arrived, however, an enormous amount of work was required to bring the base up to standard, since virtually all its facilities were inadequate to support such a significant, high-tech flight test programme.

A small army of contractors carried out the work. Nevada state law required all contractor personnel remaining in-state for more than 48 hours to report to state authorities. Such an undertaking by so many individuals would inevitably attract unwanted attention and breach the project's security. The CIA's general council therefore came up with the solution – it discovered that government employees were exempt from the requirement, so all site contractor personnel received appointments as government consultants.

◀ Oblique shot of Area 51 facilities looking south. (CIA)



One of the first tasks undertaken was to drill a new water well and recreational facilities were provided for the workers, who were billeted in trailer houses. In September 1960, work began in earnest and continued in double-shift schedules until mid-1964. In addition to a new runway, 18 miles of off-base highway was resurfaced to allow 500,000 US gals of PF-1 fuel to be trucked in every month.

◀ This image of Area 51 was taken some years after the Oxcart programme had been terminated. Note the parallel runways that extend onto the dry lakebed. (Roadrunners via T. D. Barnes)

THE RUNWAY

The runway was made of reinforced concrete, 12,000ft of which was laid on the lakebed and approximately 8,000ft more covered native soil; each end was provided with a 1,000ft graded overrun. The 8,000ft section extended out to the southeast and included a taxiway at the lake edge.

A returning A-12 could usually land and halt within this section and use the taxiway to exit the runway. Difficulties arose, however, if the aircraft overshot the taxiway entrance, since the runway wasn't wide enough to turn an A-12 without it having to venture onto the lakebed, so a turnaround pad was added to the lakebed section in 1965. A fire truck pad was positioned near the intersection of the runway and lakebed, and when A-12s were flying, a truck stood alert on the pad. Take-offs and landings were made to the northwest, enabling use of the extended runway and, if necessary, lakebed.

In fact, the lakebed proved extremely useful, especially during a high-speed abort at or beyond refusal speed and particularly if the emergency was complicated by a drag-chute failure. To aid the stopping process in this condition, an Archimedes curve was painted onto the lakebed and tightened as it extended off to the east of the runway; this increased deceleration drag without putting undue strain on the undercarriage and its attachment structure. To aid pilot acquisition, a few dead trees were positioned along the length of the curve.

The lakebed could also be used if the main runway crosswind was excessive. However, there were times when it was off-limits due to standing water, since its surface lacked load-bearing strength when wet.

NAVIGATION AIDS

INSTRUMENT LANDING SYSTEM

Prior to the operational deployment to Kadena AB, Okinawa, some A-12s were retrofitted with an instrument landing system (ILS) receiver. In order to test it, a temporary ILS was constructed at the eastern end of the lakebed, with test approaches made to the west.

TACAN

Area 51 is situated about 3 miles south-southwest of Bald Mountain, which rises to a height of 9,300ft above mean sea level (amsl). Another area of high ground, Papoose Ridge is located less than a mile to the west-southwest of the runway. Ideally a TACAN beacon would have been placed on the airfield, as close as possible to the runway it was to serve, but with high ground surrounding Area 51, this was not possible. Instead, the TACAN was situated on top of Bald Mountain, or 'Baldy' as it was referred to by the pilots. Such elevation gave the equipment an outstanding range capability, but the mountainous terrain complicated

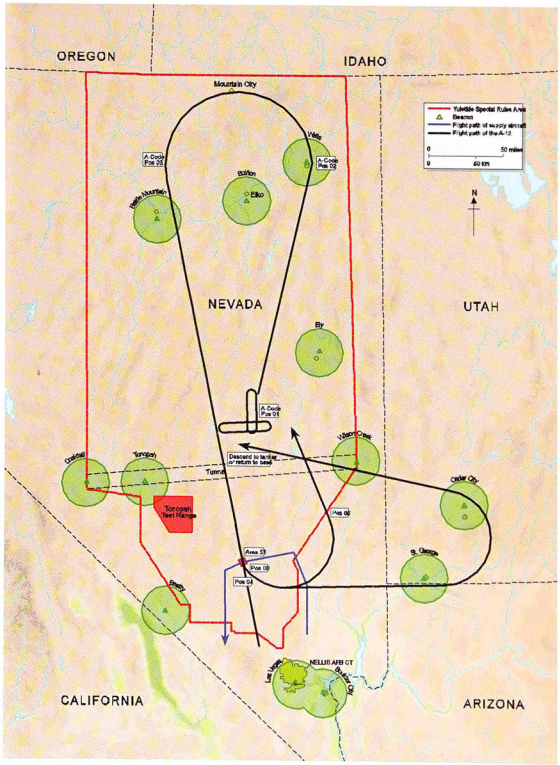
instrument approaches into the Area. Consequently, instrument approaches were made to align the aircraft inbound to runway 32. The TACAN approach was a basic teardrop let-down, with a left hand procedure turn back to the beacon on a radial that would allow the pilot to locate the runway at a specified TACAN distance and altitude. On most occasions it was used to position the aircraft to a point where the ground controlled approach (GCA) precision radar could acquire it.

GCA

The base's AN/FPN-16 GCA radar trailers were located almost directly in front of the control tower, to the west of the main runway, in between it and the main taxiway. The facility comprised two trailers, an Operations trailer and a Maintenance trailer, mounted so that they could be rotated to align the precision-approach radars using metal radar reflectors located at the approach end of the runway. The radar was powered by the base's main power grid, backed up by a generator in the Maintenance trailer; also in this trailer were air conditioning units and the surveillance radar. The Operations trailer housed the precision approach radar (PAR); PAR scopes were located in the trailer and a building situated near the tower.

Twenty-five men were assigned air traffic control (ATC) duties, including those working in the tower and approach control, and at the nearby Nevada Test Site (NTS). Eight of the enlisted controllers were dual-rated for GCA duties.

▼ The Yuletide Special Rules Area (SRA) was maintained for Mach 3 A-12 operations out of Area 51. It contained two tankers tracks, of roughly north/south, east/west orientation, with standard waypoints and turning points established at 'Pos' positions. It extended from 24,000ft up to 60,000ft and was bisected at its southern end by the 'tunnel', a civilian airway extending from 24,000 to 40,000ft, which A-12s generally had to fly under or over.



FACILITIES

In 1963, most of the housing at Area 51 consisted of old, wood frame, Babbitt duplex family accommodation acquired from the ammunition depot at Hawthorne, Nevada. More than 80 of these units were dismantled and transported through the boondocks of Nevada. At the new site they were re-erected in a quadrangle in the middle of the base and reconfigured to sleep four to six people.

Each house featured two bathrooms and two living rooms. They were also equipped with evaporation cooling systems and propane-fired boilers – most incumbents agree they were quite comfortable. One of the buildings was fitted out as the Oxcart pilots' dining room: here special low-residue meals were prepared when extended missions were to be flown. Another building, referred to as 'House 6', served as an informal gathering place and do-it-yourself bar.

In the early years of the programme the mess hall consisted of a couple of old adjoined buildings situated next to the

Operations facility. After evening meals had been served it doubled as a film theatre, managed by Jim Casteel. Later a new mess hall was constructed from where food was served 24 hours a day. Throughout the programme everyone agrees that the food, served up by Reynolds Electric Company (Reeco), was outstanding.

▲ Two of the Area 51 support aircraft during the Oxcart programme, a U-3B 'Blue Canoe' (left) and Cessna 210D. (CIA)

For recreation there was a gym, squash and tennis courts, and a small pitch-and-putt golf course. Several of the pilots and support staff also got into building and flying radio-controlled model aircraft from the dry lakebed during the evenings. Later the base built a swimming pool. This doubled up as a training facility for Oxcart pilots learning water survival techniques while wearing the full pressure suit.

During their training, Oxcart pilots also used a parasail to get up to altitude before being lowered into Lake Mead, again for water survival training. A Coast Guard power launch was the tug that launched them into the air. One pilot recalls that it wasn't the safest thing he'd ever been told to do – trying to run to lift-off in a complete pressure suit and survival kit without falling on the lake beach was, he said, decidedly 'dicey!'

The Base Headquarters building housed the 1129th Special Activities Squadron's commander, his administrative staff and the CIA station chief and his staff, as well as the Base Security Section and the medical facility, from where the flight surgeons worked.

As with all operational bases, the Mission Ops Building was the hub for flying operations and included regular base ops functions, a main mission briefing room, a flight planning section and a personal equipment section, where flight suits and pressure suits were kept and maintained. It also housed the Stan/Eval section. The Stan/Eval pilots were responsible for training and maintaining flying standards.

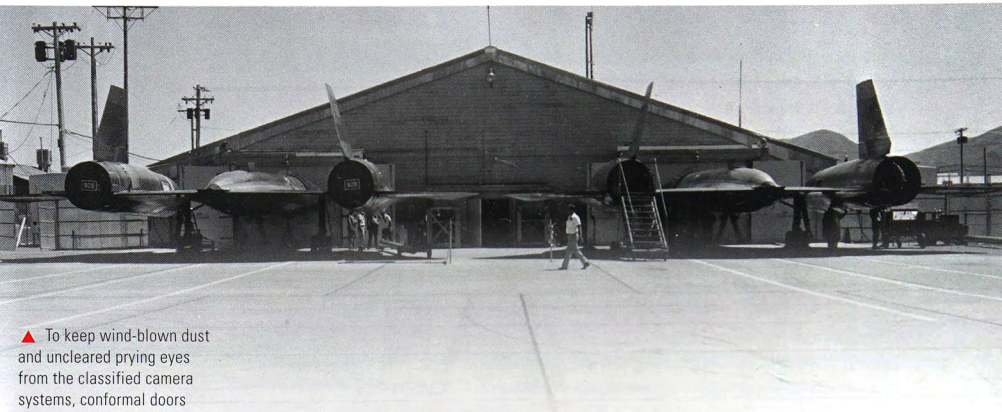
There were also offices for the project pilots. The CP was located within the building's inner sanctum. On one of its large walls was a map of the United States upon which were detailed all the usual A-12 flight routes; its backing was sheet steel and small magnetic A-12 silhouettes, on which individual serial numbers were engraved, were positioned along the routes being flown, enabling CP personnel to keep a check on proceedings. Adjacent to the CP was the Secure Communications Room; radios were used to monitor most missions within the US, as were HF/SSB and Birdwatcher.

Finally, at the rear of the building the meteorological section and a small Link trainer room were located. A separate building near the main taxiway served the security needs for classified document control. Fenced and patrolled by security guards, it was opened for access by the 'crew bus', which carried project pilots to the Agency hangars and contractor test pilots to the Lockheed hangars and their dedicated test aircraft.

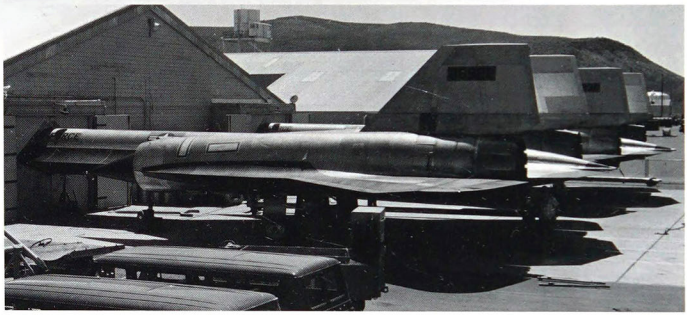
▼ Jack Layton is made ready for a parasailing training sortie, which culminated in a 'feet-wet' landing in Lake Mead. Frank Murray said jokingly of the event, 'I'm sure they were trying to drown us all so they wouldn't have to pay us our enormous pay cheque!' (Roadrunners via T. D. Barnes).

HANGARS

The A-12 hangars and the main parking ramp were located on the southern perimeter of the base, connected to the main runway by a taxiway. Three large ex-US Navy hangars were moved to the test site and housed the A-12s while they were being reassembled. They also provided hangarage for two Lockheed F-104 chase aircraft, and test Articles 121 and 122. Article 129 spent some time in this accommodation during flight trials, before its return to the Agency as mission aircraft.



▲ To keep wind-blown dust and uncleared prying eyes from the classified camera systems, conformal doors were fitted to one of the earlier U-2 hangars, enabling the A-12's nose section to be 'docked' inside. (CIA)



▶ Oxcart Articles 125 (60-6928) in the foreground and 127 (60-6930) in the nose-docking hangar. (CIA)

Several old hangars from the U-2 days remained on-site and these served as engine and machine shops; other smaller buildings housed the avionics facility and another the INS repair station. A huge metal-clad warehouse was home to the Logistics Supply Center, while a large petrol, oil, lubricant (POL) dump, located away from most other structures, stored the fuels required by aircraft and base vehicles.

Custom-built hangars housed the project aircraft. They had doors at either end to facilitate drive-in, drive-out operations and in-hangar engine starting. A large central bay, flanked on each side by more hangars, provided offices for maintenance staff and several specialization shops. Opposite these hangars was located the 'peek building', designed to cover the nose section of the A-12 while the highly classified camera systems were being installed. The Oxcart was pushed nose-first into the facility and sliding doors to either side were closed to encapsulate its forward section; in addition to providing additional security, it kept wind-blown sand and other debris away from sensitive optics.

Another single-bay hangar was used for the maintenance of support aircraft and housed several F-101 chaseplanes.

RATSCAT RANGE

A radar target scatter range was built north of the main Lockheed hangars. It comprised threat simulators, precision radars and optical systems; the latter could be used to track A-12s from

the ground as they flew local test sorties. The RatScat equipment assessed the RCS of sub-scale and full-scale aircraft during the early development days of the A-12. The test subject was mounted atop a hydraulic lift, located some distance from the radar head, on the dry lakebed and then positioned at various aspects. The lift was masked with Echosorb before readings were taken of the aircraft's RCS. A-12 Article 122 spent several months on 'the Pole'.

SUPPORT AIRCRAFT

During the spring of 1962, eight F-101B/F Voodoos arrived, mainly for use as chase aircraft flown by the project pilots. Two F-104s were also assigned for high-speed chase and mainly flown by Lockheed test pilots before being re-assigned to Edwards AFB when the three YF-12 were re-located. In addition, two T-33As were provided for mission support and proficiency flying for the many military staff pilots.

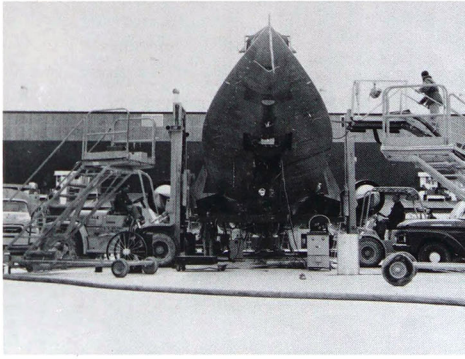
Light air transport was provided by a U-3B 'Blue Canoe' flown by some of the staff, while a civilian-registered Cessna 180, later replaced by a Cessna 210, was used on medevac and utility duties. Base rescue, fire suppression and local security was covered by an HH-43 before a UH-1 Huey replaced it. Logistics support, particularly for ferrying the J58 engines in and out of the base, was conducted by a C-130.

The weekly commute of staff into Area 51 from Las Vegas, as well as the airlift of special devices used for local technical studies, was initially achieved using a C-47 (later replaced by a Fairchild F-27, both aircraft operated under contract by Carco Inc). The majority of contractors, Lockheed workers and project pilots alike, made the Monday/Friday trip into and out of Area 51 in Constellations operating into Burbank. Another visitor to the desert base was Lockheed's prototype twin-engined JetStar, used by the likes of Kelly Johnson and his senior team.

That the physical location of Area 51 was an ideal secure site from which to conduct the Oxcart test programme is beyond dispute, but, there were additional special needs that needed to be met to ensure the aircraft and its associated chaseplanes could operate safely. In response, an agreement was reached between the FAA, the Air Force and the Agency, setting aside a vast area of airspace. It joined the northern borders of restricted areas 4806, 4807, 4808 and 4809,

▲ Major Charlie Trapp flies Area 51's HH-43B during a fire exercise in crew extraction from a crash site. The helicopter's rotor downwash cools the area, spreads the foam and clears away smoke. (CIA)

▼ An unidentified A-12 during ground fuel tests at Area 51. When cruising at high Mach, the A-12 had a positive deck angle of 7° nose high. This test replicated this configuration by using two forklift trucks to raise the nose undercarriage to the appropriate height. The aircraft's fuel transfer sequence was then activated and PF-1 pumped into the bowsers, simulating consumption by the engines. Adjustments could then be made to the feed sequence prior to flight. (Roadrunners via T. D. Barnes)



▲ The two-seat AT-12 pilot trainer accumulated more than 1,076 hours in 614 flights out of Area 51 before the Oxcart programme was terminated. (Lockheed Martin)

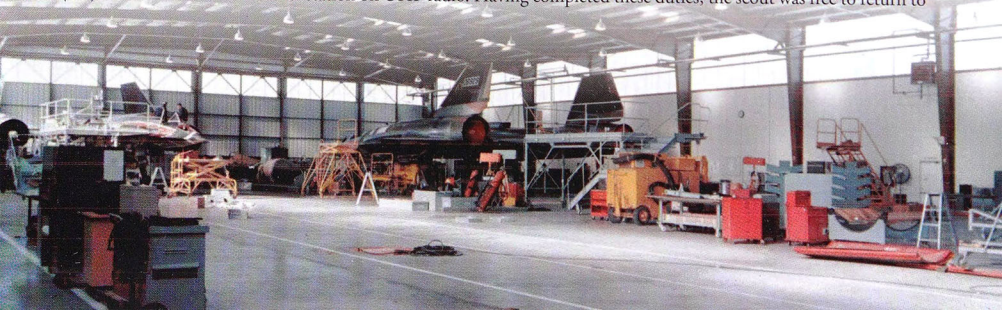
and ran north in a box bordered by the navaids at Wilson Creek and Coaldale. The area extended to 42° north and was bordered to the east by 115° west and to the west by 118° west. Designated the Yuletide Special Rules Area, it rose vertically from 24,000 to 60,000ft amsl.

Flight above 60,000ft wasn't subject to FAA positive control, but for additional safety, when A-12s began operating routinely above this, their pilots used a simple code to hide their actual height from eavesdroppers by reporting that they were at an altitude of base plus a number. For additional security, the base altitude would change daily, so if, for example, it was briefed as 50,000ft and the Oxcart was cruising at 85,000ft, the pilot would report to the centre that he was at base plus 35. In this way ATC could keep a watchful eye out for other high-flying traffic and later, when SR-71s and U-2s were flying in those upper reaches, controllers would sometimes report 'company traffic' at an azimuth relative to the Oxcart's flight path.

To accommodate a civilian airway that ran between the Wilson Creek Vortac and that at Coaldale, a 'tunnel' 10nm wide between 24,000ft and 40,000ft altitude was established. Area 51 traffic had to fly below or above it, or obtain prior clearance from Salt Lake ATC Center to fly through it. When the A-12 began test operations out of Area 51, most pilots elected to fly beneath the corridor northbound after take-off en route to the tanker and fly over the top southbound, especially if the A-12 was on the descent into the SOA. When the SOA was not required to support A-12 operations, the airspace reverted back to Salt Lake Center for use by airline and general aviation traffic.

Since there were no weather-reporting stations within the SOA, a weather scout was used. During the summer it launched from Area 51 at about 6:00am, or at first light during other seasons. The weather scout, in an F-101, usually flew 200 miles to the north, paying particular attention to cloud conditions in the refuelling areas and reporting conditions to Area 51's weather station on UHF radio. Having completed these duties, the scout was free to return to

▼ Two A-12s under routine maintenance in one of Area 51's hangars. The aircraft on the right is 60-6929 (Article 126), which was lost on take-off on 28 December 1965. (CIA)



home plate via any route desired, usually before any other aircraft had taken off. One or two of the more mischievous pilots used the opportunity to check out the security guard post on the dirt road leading to the east of Bald Mountain – it seems that many a guard was startled back into reality by an extremely fast and very low returning weather scout! Upon landing the F-101 pilot reported to the weather station and command post, and related his report in more detail if required.

During a chase sortie on 26 September 1967, F-101B 56-0286 was returning home in company with the 'Titanium Goose'. It was already quite dark and while the AT-12 was nearing the approach to runway 32 at about 8,500ft, it appears that the chase pilot, James S. Simon Jr, lost visual contact with his charge. The Oxcart pilot told Simon that he was okay and had no further need for the chase aircraft; the A-12 then turned onto final.

When asked where he was, chase replied, 'In trail and moving over to the right side.' Shortly thereafter a fireball was seen to streak across the desert. The AT-12 pilot initiated a go-around at 500ft and 190kt. The wreckage of '0286 was found 4,000ft short of runway 32 and 2,000ft to the right of its extended centreline. It was determined that James Simon had made no attempt to eject and the CIA accident report concluded that he had inadvertently flown into the ground.

Another duty performed by staff and project pilots before the start of a day's flying was a security check of the Area's 'perimeter'. It was flown in the Cessna 210 as well as the HH-43/UH-1.

UNINVITED VISITORS

Mindful of the wilder imaginings of some elements of the media, several members of the Oxcart programme have confirmed that there were definitely *no* aliens at Area 51, at least not during their stay at the isolated base. However, uninvited visitors did drop in from time to time. Denny Sullivan recalls that one night a young lady and her rather drunk pilot boyfriend arrived. 'It seems that he convinced her that it was a good idea to fly from Reno down to Las Vegas in this lightplane to continue the party. He evidently lost his way and was getting low on fuel when he saw this nice big runway and landed. He was met by the security folks and, as I understand it, during the session with security, the gal got into seriously berating the guy for his stupidity and whacked him one with her purse!'

On another occasion Frank Murray missed the last Friday night Connie flight back to Burbank due to the late completion of an FCF. He was in his base house on the Saturday morning when he heard the sound of a light aircraft flying over the base, so he ventured out to see what was going on, as he now recollects. 'At about this time one of the security guys drove up and told me that someone was landing on the taxiway. I jumped in the truck and went to see. As we caught up with our "guest" he was shutting down on the apron in front of the big hangars. The guy then stepped out and said "God, am I glad to be down, I've been flying around his huge desert, lost".

'It turned out he was a student pilot, ex-USAF navigator, flying one of his solo cross-countries out of Apple Valley, California. Security checked out his story and decided to let him go with the usual signing away of his life about the Area. We filled up his little airplane with Mogas [Avgas] and told him to taxi out to the main runway and head off southeast and don't turn. He flew off to the cut in the ridges southeast of the Area and I never saw him again. I then went back to the house to

▼ This group of Oxcart personnel includes (from left to right) Jack Layton, Dennis Sullivan, Mele Vojvodich, Lt Col Burt Barrett, Jack Weeks, Ken Collins, Walt Ray, General Ledford, Bill Skliar, Lt Col Cy Perins and Cols Holbury, Kelly and Slater. (CIA)

▲ Towards the end of project Oxcart, some facilities at Area 51 were used by the 6513th Test Squadron, the 'Red Hats'. Under the classified Have Doughnut programme, Air Force Systems Command (AFSC) conducted exploitation and evaluation of an Iraqi Air Force MiG-21F-13 "Fishbed-E" acquired by the Israeli Air Force after its pilot defected. To ensure programme security wasn't compromised, the aircraft was referred to as a YF-110B for 'administration purposes'. (US DoD via T. D. Barnes)

continue work on building my radio-controlled model aircraft.'

Although similar incursions occasionally punctuated life at the test area, it is believed there was only one case of a 'guest' actually seeing an Oxcart; it occurred late on the morning on 29 June 1965. RAF exchange officer Flt Lt Jock Heron got airborne from Nellis AFB in F-105D 59-1772 of the 4526th Combat Crew Training Squadron (CCTS), 4520th Combat Crew Training Wing (CCTW), on a simulated nuclear weapons delivery sortie to one of the Nellis ranges. Jock recalls that sortie in an extract reproduced by courtesy of the Rolls-Royce Heritage Trust (Bristol):

Having released a practice bomb I pulled off the target and suddenly the cockpit filled with smoke. Despite following the usual emergency procedures the problem remained, so with thoughts that an internal fire had developed, I declared an emergency and had little alternative but to seek authority to land immediately at The Ranch, which lay on the edge of a dry lakebed some 15 miles to the south east, inside the prohibited area of the test site. Permission was duly gained and my credentials were passed to the control tower using the emergency frequency.

The airfield looked deserted as I passed through the overhead before setting up for my approach and landing. The 'Thud' was well over maximum landing weight and I flew a wide circuit before making my final approach at a higher than normal speed to allow for the extra 8,000lb of fuel. Touchdown was straightforward and gentle, the braking parachute deployed normally and the aircraft slowed gradually to normal taxiing speed before turning off the long runway. I then shut down the engine and electrical power because of the continuing risk of an internal fire from the source of the smoke, which did not disperse until the canopy was opened.

Two vehicles met me, one of which was an engineering truck and crew, the other contained two men in civilian clothes. Having dismounted from the aircraft and ascertained that there were no external signs of fire I left the aircraft in the hands of the ground crew and was invited to board the second vehicle, which took me to one of the hangars adjacent to the aircraft parking area. Conversation was limited to the events surrounding the aircraft's emergency and I was escorted to a room without windows where I was given a welcome cold drink.

The ensuing debriefing was courteous but prolonged and I was reminded of the classified nature of the airfield. After about an hour, one of the ground crew appeared and confirmed the cause of the smoke in the cockpit. Apparently the cold air turbine for the cabin air refrigeration system had seized and the overheated lubricant had ignited within the system. Although there was no real danger to the aircraft, the effects in the cockpit were consistent with the system failure. In the light of the evidence of a genuine malfunction, the two men adopted a more relaxed manner and we exchanged flying banter for a time. It was agreed that I could return to base without the cold air system which, because of the failure, would be isolated by the engineers.

One of the hosts looked at his watch and invited me to follow him outside. We stood in the baking midday sun at the edge of a large dispersal pan where there were two aircraft parked, an F-104D Starfighter and a F-101B Voodoo, both of which were two-seaters. There was an audible deep engine noise that wasn't generated by either the

J79 of the F-104 or the two J57s of the F-101, but there was no sign of any other aircraft. A few minutes later the F-101 started its engines and my host then said, 'You'll be interested in this'.

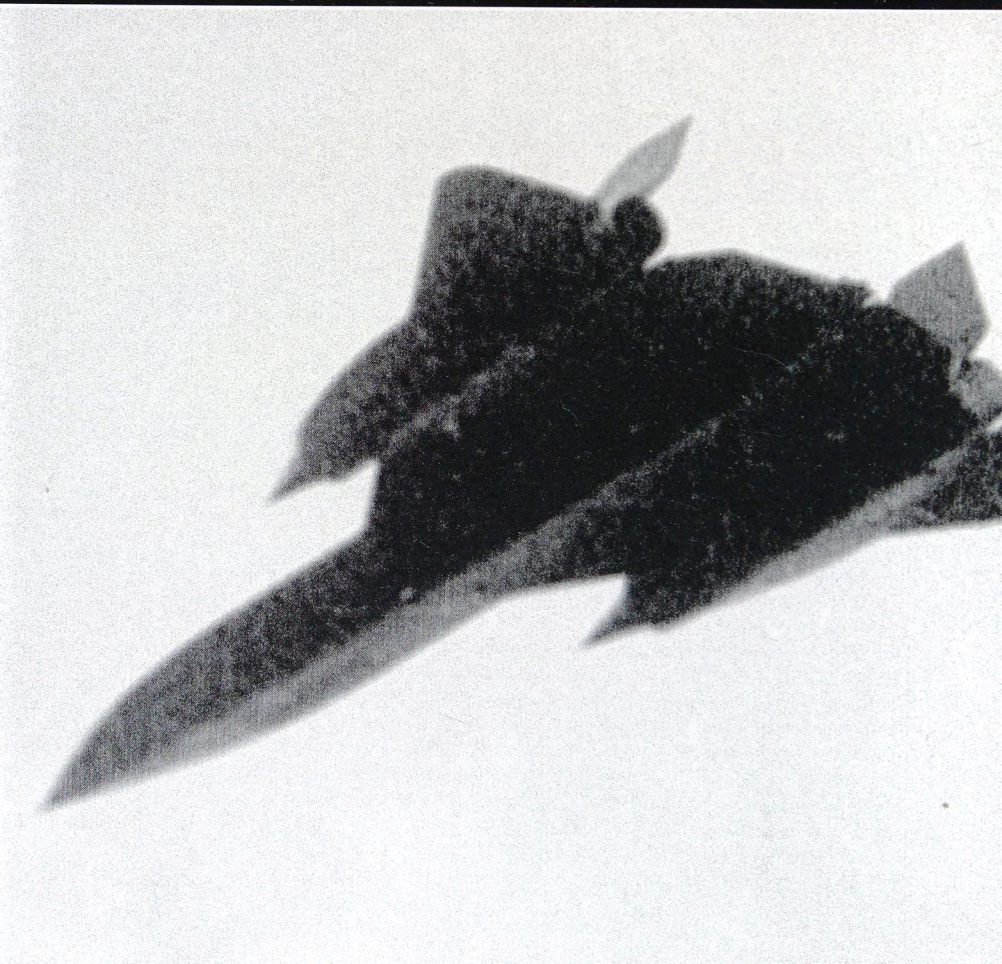
The doors of the 'hangaret' opposite opened to reveal the source of the earlier unidentified engine noise. It was an aircraft pointed straight at our position, which I was to identify later as the forerunner of the SR-71. This sleek black shape then emerged from its cover, passed us while taxiing to the end of the runway and took off with the Voodoo in pursuit. Naturally as a young flight lieutenant I was awestruck to have been so close to this spectacular product of the Lockheed Skunk Works.

After a quick snack lunch I was returned to reality because my aircraft was pronounced ready to fly and it was time to leave the remote test site and fly back to Nellis. After a final word from my host of the need for complete discretion I boarded my Thud, started the engine, taxied to the end of the runway and took off for the short flight back to Nellis. Because of the lack of air conditioning, I climbed to a relatively cool 10,000ft and turned my back on The Ranch, conscious that I was privileged to have been there.

The following day I was flying another Thud on the same bombing range with a student flying on my wing when he suffered a fuel transfer emergency and again the procedure for such a failure was to land as soon as possible. When asked by the air traffic control tower at the test site to pass my flight details on the emergency frequency, I said merely 'same as yesterday'. I was told that I could return to Nellis after monitoring my student's landing. Perhaps the authorities had seen enough of the visiting Scot at The Ranch and two days running was too much!

▲ This frame-grab is from footage shot inside an Area 51 hangar between February and May 1969. In the background can be seen an ex-Syrian Air Force MiG-17 "Fresco-C". It was associated with an AFSC programme code named Have Drill and the aircraft was referred to as a YF-113A. Note the Israeli Air Force pilot (centre), proving the still-to-be officially acknowledged fact that Israeli personnel were directly involved in MiG exploitation at Area 51. (Paul F. Crickmore collection)

CHAPTER 5



UPWIND, SKYLARK AND BLACK SHIELD

On 1 January 1964, unique equipment used to support the A-12 and stored at Mira Loma Depot was moved to San Bernardino Air Materiel Area, Norton AFB, California. Concurrently, Air Logistics Command at Wright-Patterson AFB assumed full manpower and logistics control at the depot for Oxcart, the D-21 drone project (Tagboard) and the up-coming Air Force Senior Crown programme.

In 1964, KH-4 Corona satellite imagery obtained evidence of what some analysts believed was an anti-ballistic missile site at Tallinn, Estonia. Photo-interpreters contended that 12 to 18in. resolution imagery was needed to determine the size of the missile, the antenna pattern and configuration of the engagement radars associated with the so-called Tallinn system. The limited resolution of satellite, or 'overhead' imagery at that time could not produce the required level of detail to resolve the debate.

◀ No high-quality images have emerged of A-12s participating in Operation Black Shield. This frame grab was taken from 16mm film, shot, it is believed, by the CIA's station head of security. (CIA)

▲ Ken Collins (Stateside personal call sign Dutch 21) completed his first *Black Shield* mission on 13 July 1967. He completed six operational sorties before the programme was terminated. (Lockheed Martin)

To settle the issue, the Office of Special Activities (OSA) proposed that a composite mission should be flown consisting of an Oxcart equipped with a high-resolution camera and a U-2 configured for gathering ELINT. The highly classified proposal had the unclassified code name Project Scope Logic and the classified cryptonym Project Upwind. The A-12 would fly from the United States over the Baltic Sea, where it would coordinate with the U-2. It would then proceed to the north of Norway before heading south along the Soviet-Finnish border. Just prior to reaching Leningrad, the A-12 would head west-southwest down the Baltic Sea, skirting the coasts of Estonia, Latvia, Lithuania, Poland and East Germany, before heading back west to the United States. The 11,000-mile flight would take 8 hours 40 minutes to complete and require four air refuellings.

Although it wouldn't violate Soviet airspace, it was hoped the high-speed, high-altitude target would provoke Soviet radar operators into activating the Tallinn system. The A-12, with its Type 1 camera, would secure high-resolution imagery of the Tallinn site and the more vulnerable U-2 would stand off beyond SA-2 range, recording the radar's signal characteristics. Agency and DoD officials supported the proposal, but Secretary of State Dean Rusk was strongly opposed and the influential 303 Committee never forwarded the proposal to President Johnson for his approval.

Another possible area of operations for Oxcart was Cuba. By early 1964, project headquarters had already begun planning for possible 'contingency overflights' under a programme codenamed Skylark. Four of the 13 A-12s now at Area 51, Articles 125, 127, 128 and 132, were initially designated as primary Skylark aircraft. They were later joined by aircraft 129 and 131 following modifications.

A luncheon meeting held on 15 September 1964, in Secretary of State Dean Rusk's dining room and attended by Secretary of Defence Robert McNamara, National Security Advisor McGeorge Bundy and Director of Central Intelligence McCone, discussed the limitations of satellite coverage of Cuba in the context of monitoring assurances made by the Soviet Union not to redeploy nuclear missiles on the island following the 1962 crisis.

▶ Jack Layton (Stateside call sign Dutch 27), pictured in his David Clark S-901 pressure suit, completed six *Black Shield* missions. (Lockheed Martin)

The discussion also covered the vulnerability of the U-2 to undertake such missions in the light of a very real SAM threat. It was pointed out that Oxcart overflights would be 'far less vulnerable than the U-2, but not entirely invulnerable, however, because of the sonic boom in addition to radar detection.' McNamara took a slightly opposing view, believing the vulnerability of the A-12 would only increase 'if we engaged in frequent flight over a pre-determined pattern the Cubans might put some of their SAMs in a state of alert which would very possibly catch an Oxcart.' However, he thought that one flight every 30 days would provide enough coverage of the island to fulfil the United States Intelligence Board (USIB) requirements.

Others in attendance disagreed, particularly on the number of sorties required, given a study of the weather over Cuba, especially if substantial coverage of the island was to be achieved. It was agreed that the subject should receive further study, and that this should include Oxcart vulnerability under the Skylark programme and a substantive judgement as to the number of flights required from November 1964 to November 1965 in order to accomplish acceptable coverage of the island with usable photography.

To bring the A-12s up to the standard required to participate in the envisaged missions, a two-point plan was developed. Phases I and II were to begin simultaneously on 1 March 1965. Phase I focused on increasing the aircraft's regular speed envelope out from Mach 2.9 to Mach 3.05. Phase II concentrated on proving Oxcart's ability to undertake three air refuellings during the course of a mission, while an element code named Supermarket related to improvements in the A-12's ECM system. Perfecting the latter seemed to be taking a disproportionate amount of time, causing the CIA to try a different approach. This led directly to project Kempster.

Tests demonstrated that a vertically polarized radar wave aimed at the front of the A-12 would couple with the aircraft's inlets, causing energy to flow along the outside of the nacelles, reflect from their rear section and travel forwards again before being re-radiated towards the radar head. Theory suggested, however, that if a cloud of ionized gas could be created around the A-12 using a particle accelerator, the aircraft would be rendered invisible to radar.

The Agency hired Nick Damaskos to head Kempster, a project pursuing the ionization technique. Design and construction of the equipment was contracted to Westinghouse Research Laboratories and the contract began on 3 June 1963. The project progressed into experimentation to determine the power of the beam that would be necessary to produce the required amount of attenuation.

Initially, test equipment installed in the Q-bay of an A-12 sent an electron beam downwards from the fuselage, blocking transmission from an antenna behind the beam. This proved successful, so a new version was built that sent a beam sideways from the chine in front of the inlet, ionizing air before it reached the inlet. However, the system required virtually all the power generated by the aircraft to work. The electron beam was pulsed on and off 100 times per second, causing the radar return to switch at the same rate between its normal high return and a lower amount.

▼ Frank Murray (stateside call sign Dutch 20) completed four *Black Shield* missions. (National Archives via Lin Xu)

The system was installed in Article 126 and after successful testing on the pole at Area 51, was flight tested in October 1963. By December 1964, flights were being made in Article 131. They revealed that every time the electron beam pulsed on, the radar return from the inlet dropped by a substantial amount. This prompted the design to be progressed to an operational version that could run continuously while taking up less power and space.

Phase I of Kempster concluded in March 1965. Money from the NRO financed Phase II which, in addition to further studies, was also to develop four operational prototypes. On 3 August 1966, ELINT specialists from the CIA's OSA, together with its deputy director, John Parnagosky, reviewed progress to date and noted cost overruns and schedule slips. However, this ground-breaking technology had applications way beyond Oxcart and the group therefore recommended extra funds be made available

and that additional funding be procured from the NRO to fund Kemspter B, a new Westinghouse theoretical study. But Carl Duckett, the CIA's Deputy Director for Science & Technology (DDS&T) rejected the proposals. Within the Agency, the package was known as Catnap and considered as part of an upgrade package for an A-12B follow-on, but Oxcart was cancelled and the upgrades never happened.

In the event, alternative modifications proposed for Skylark provided the A-12 with the required capability. In the interim, on 5 August 1965, the Director of the NSA, Gen Marshall S. Carter, directed that Skylark was to achieve emergency operational readiness by 5 November. Should security considerations dictate, any contingency sorties would have to be executed below the optimum capability of the A-12 (nearer to Mach 2.8); in order to meet this tight timeframe, the Oxcarts would have to deploy without their full ECM suite. Despite the difficulties, a limited Skylark capability was ready on the date prescribed.

In the event, these Cuban contingencies were never implemented and on 15 September 1966, the 303 Committee finally voted not to commit Oxcart to Cuban reconnaissance missions on the basis that it could disturb the prevailing political calm. Instead, a more critical situation had developed in South-East Asia and this took priority.

BLACK SHIELD

On 27 January 1965, the first in a series of long-range, high-speed, high-altitude proving flights code named Silver Javelin occurred. Article 129 completed the 2,580nm flight in just 1 hour 40 minutes, 1 hour 15 minutes of which was spent at speeds above Mach 3.1, while cruising altitudes between 75,600 and 80,000ft were achieved. On 18 March, the CIA and DoD leadership agreed to take preparatory steps towards operating the A-12 over Communist China and by year's end all the Agency's project pilots were Mach 3 qualified.

On 22 March, Brig Gen Jack Ledford briefed Deputy SecDef Cyrus Vance on Project *Black Shield*, the planned deployment of Oxcart to Okinawa in response to the increased SA-2 threat facing the U-2 and Firebee drone reconnaissance vehicles used over Communist China. Overflights of China would obviously have to be approved by the president, but Secretary Vance was willing to make $3.7 million available to provide support facilities at Kadena AB, which were to be ready by autumn 1965.

On 3 June 1965, SecDef McNamara consulted with the Under Secretary of the Air Force on the build-up of SA-2 missile sites around Hanoi and the possibility of substituting A-12s for U-2s on recce flights over the North Vietnamese capital. He was informed that *Black Shield* could operate over Vietnam as soon as adequate aircraft performance was validated.

On 20 November 1965, the final stage of the Silver Javelin validation process was completed when a maximum-endurance flight of 6 hours 20 minutes was achieved, during which the A-12 demonstrated sustained speeds above Mach 3.2 at altitudes approaching 90,000ft. On 30 November 1965, Kelly logged, 'As of this date we have three aircraft that are operational. We were instructed to maintain a degree of readiness so the aircraft could be deployed in two weeks.'

On 2 December 1965, the highly secretive 303 Committee received a formal proposal to deploy Oxcart operations to the Far East. It was quickly rejected, but the Committee agreed that all steps should be taken to develop a quick-reaction capability for deploying the A-12 reconnaissance system within a 21-day period any time after 1 January 1966.

On 12 May 1966, Kelly recorded in his log, 'As of this date, there is still no go-ahead for the deployment, although it seems fairly optimistic. The airplanes are ready to go. We do not yet have the range up to the design value, but ⅔ of the loss has been due to weight changes

due to added equipment. ⅓ of it is due to loss in range cruising. We can do about 3,000nm, but they, of course, do not get the range that we can.'

Throughout 1966, numerous requests were made to the Committee to implement the Black Shield operations order, but they were turned down. A difference of opinion had arisen between important government factions that advised the Committee – the CIA, the Joint Services Committee (JSC), and the president's Foreign Intelligence Advisory Board favoured deployment, but Alexis Johnson of the State Department and Robert McNamara and Cyrus Vance, both of the Defence Department, opposed it.

On 15 August 1966, Kelly noted, 'We do not yet have permission to deploy, although this looks a little more favourable now. Our morale is poor, as there seems to be no direction to the program.'

▲ Mele Vojvodich successfully completed the first operational Oxcart mission of Operation *Black Shield* on 31 May 1967. During Stateside training sorties, his personal call sign was Dutch 30. (Lockheed Martin)

Meanwhile, training and testing continued, while mission plans and tactics were also prepared to ready the operational 'package' for deployment should the Black Shield plan be executed. Deployment timing was cut from 21 to 11 days and the base maintenance facility at Kadena AB stocked with support equipment. To further underwrite the A-12's capability to carry out long-range reconnaissance missions, Bill Park completed a non-stop 10,200-mile flight in just over 6 hours on 21 December 1966.

Fifteen days after Park's proof-of-range flight, tragedy struck the programme with the crash of another jet; this time the incident claimed the life of its pilot. Walt Ray had logged 358 hours in the A-12 when he got airborne from Area 51 at 11:50am (local time) on 5 January 1967, using his personal call sign Dutch 45.

The mission was scheduled as a routine training and test sortie, and shortly after take-off Ray successfully completed his first AR, taking on board 36,000lb of fuel. Completing the first high-speed, high-altitude leg of the sortie, he descended for a second AR; this time his fuel on-load was 61,000lb. This was 4–5,000lb less than planned, since the tanker reported it was running low on gas. To make up for the shortfall, Walt planned to execute a fuel saving, reduced-power climb during the next leg; his fuel management skills seemed to have paid off when, having completed his final turn back to home plate, he was a manageable 800–1,000lb off schedule.

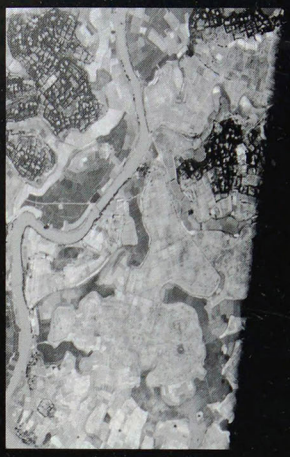
However, nearing Framington, New Mexico, the aircraft should have had about 13,000lb on board, but at 3:22pm Walt reported that he was down to 7,500lb and commented on the radio transmitter (R/T), 'I don't know where it's gone'. Thirty minutes later, during the descent near Hanksville, Utah, he reported that he was low on fuel and just one minute later he declared an emergency. At 3:56:27, Walt radioed that he was 130 miles out, had just 4,000lb of fuel left and that he was losing it at an excessive rate. Five minutes later he reported that the fuel low-pressure lights had illuminated then, after 30 seconds he reported that the engines were flaming out.

At 4:03pm Walt made his final radio call, stating that both engines had flamed out and he was ejecting. Article 125 (60-6928) had run out of fuel 70 miles short of Area 51. After 'gliding' to a lower altitude and executing what appeared to be a controlled ejection, Walt had failed to separate from the ejection seat and was killed when he hit the ground.

The circumstances leading up to the loss of this outstanding pilot and extremely popular member of the programme were particularly ironic. Almost a year earlier, on 25 January 1966, SR-71A test vehicle '952 had been lost by Lockheed flight test crew Bill Weaver and Jim

◀ Successful prosecution of Operation Black Shield was dependent upon both the aircraft and its Type 1 camera package. This image, taken on mission BX6709 on 19 July 1967, shows the entire film area captured by the camera's right scanning head. (National Archives via Lin Xu)

▶ To aid photo interpreters, each frame was annotated at its outer edge. The position of the A-12 during this exposure was latitude 20° 58' north, 105° 47' east (near Hanoi). On the label below are three digits (relevance unknown), followed by the mission designation BX6709 (Black Shield (BX) year 1967, ninth mission of the year). Time is GMT 2:00am (local time 10:00am). 'GRD SPD' is ground speed in knots – the first digit, '1' of '1,000', is omitted, so the Oxcart was flying at 1,862kt (2,234mph). (National Archives via Lin Xu)



Zwayer during a range-extension test in which Zwayer was killed. Post-accident investigation revealed that the back-seater had died from a broken neck, sustained as the aircraft disintegrated following a Mach 3 pitch-up.

The violent whiplash that resulted from the high-speed break-up of the aircraft, and the G-forces that slung Zwayer and Weaver about as they were forcibly torn from their non-ejected seats, slammed Zwayer's head back against the headrest. It was further determined that because of Zwayer's short stature, his headrest was further back due to the thickness of the parachute's backpack.

Subsequent to that accident, Lockheed undertook flight-safety modifications to the seat's headrest cushion, tailoring it more closely to the contours of individual crewmembers to provide support and protection from future whiplash injuries. Walt's extended headrest had caused his parachute to become trapped between the seat well and the headrest so that the 'butt-snapper' straps (which had attempted to work as advertised) couldn't push Walt free of his seat. The accident was a bitter blow to the deployment timing of Oxcart. The *Los Angeles Times* reported the accident and identified the aircraft as an 'SR-71 Experimental Reconnaissance jet' and Walt Ray as a 'Lockheed test pilot'.

In May 1967, the National Security Council was briefed that North Vietnam was about to receive surface-to-surface ballistic missiles. Such a serious escalation of the conflict would certainly require hard evidence and President Johnson was briefed on the threat. Richard Helms (the new DCI) again proposed that the 303 Committee authorize deployment of Oxcart, as it was ideally equipped to carry out such a surveillance task, having superior speed and altitude to the U-2s and pilotless drones, as well as a better camera. President Johnson approved the plan and finally, in mid-May, an airlift was begun to establish Black Shield at Kadena AB.

OPERATIONS

At 0800 on 22 May 1967, Mele Vojvodich departed Area 51 in Article 131, 60-6937, and headed west across California for his first refuelling. Having topped off, he accelerated to high Mach towards the next air refuelling control point (ARCP) near Hawaii. A third rendezvous

took place near Wake Island to ensure he had reserve fuel sufficient to divert from an intended landing at Kadena to either Kunsan AB, South Korea or Clark AFB, Philippines (1,200 miles beyond Kadena), should the weather over Okinawa deteriorate. The weather was fine and Mele let down for landing after an uneventful flight of just over six hours. Had it not been for the deployment's secrecy, the flight might have been recognized as a new transpacific speed record.

Two days later, Jack Layton set out to repeat Mele's flight, but aircraft 127 (60-6930) experienced an air data computer failure shortly after take-off and Jack lost the important knots equivalent airspeed (KEAS), Mach number and altitude read-outs on his triple display indicator TDI). Loss of the TDI was an 'abort item' on his 'GO-NO-GO' checklist, but Jack (like all the Oxcart team) was acutely aware of the pressure on the programme to succeed. He therefore chose to continue the flight, calculating bypass door and inlet spike position schedule changes by temperature gauge indications.

That careful action proved successful and Jack landed the second aircraft at Kadena in under six hours. He was met after engine shut-down by his old flying instructor and now A-12 Det commander, Col Slip Slater, who asked if there were any maintenance write-ups, to which Jack replied, 'Only the TDI'. 'When did you lose that?' Slip pressed. 'A way back,' answered the A-12 driver. 'How far a way back?' continued the colonel. 'Well, just after take-off, actually,' Jack admitted. 'You crazy SOB,' Slip laughed and never again mentioned the incident.

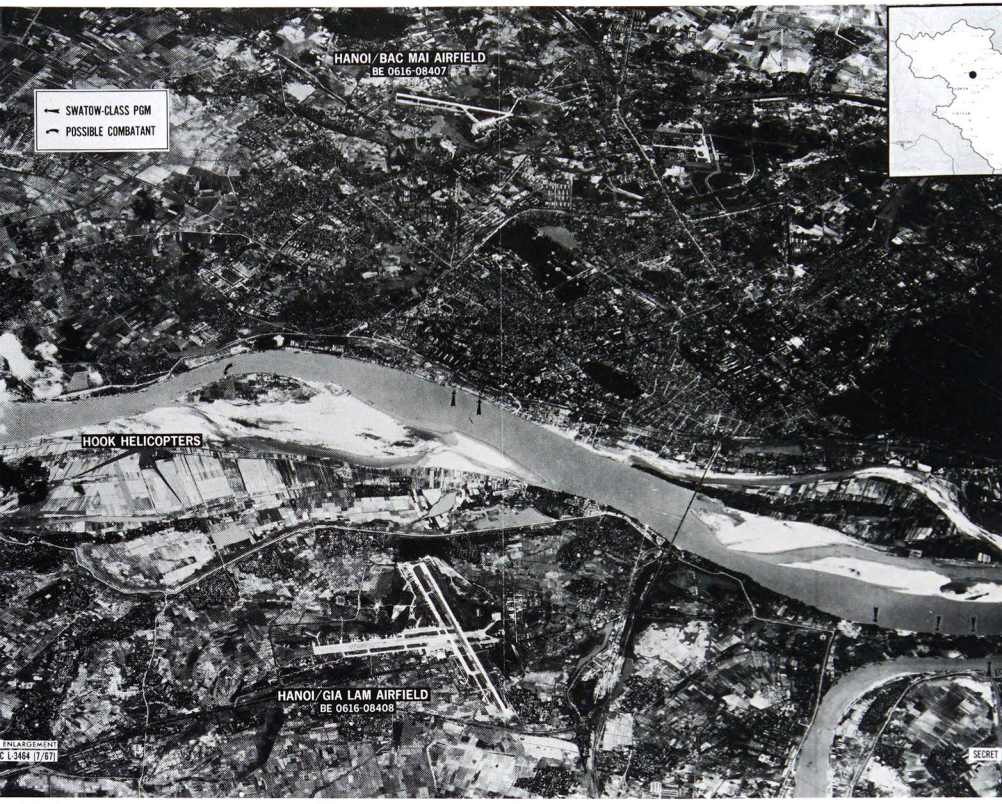
Jack Weeks left Area 51 on 26 May, but due to INS and radio problems he was forced to divert into Wake Island. An Oxcart maintenance team arrived in a KC-135 from Okinawa the following day to prepare 129 (60-6932) for the final 'hop' to Kadena. After completing the journey, Jack's aircraft was soon declared fit for operational service along with 127 and 131. The detachment was declared ready for operations on 29 May and based on data from an in-theatre weather reconnaissance flight the day after, it was determined that conditions over North Vietnam were ideal for an A-12 photo-run.

FIRST OPERATIONAL MISSION

Project headquarters in Washington then placed *Black Shield* on alert for its first operational mission. Avionics specialists checked systems and sensors, and at 1600 Mele Vojvodich and back-up pilot Jack Layton attended a mission alert briefing that included such details as the projected take-off and landing times, routes to and from the target area, and a full intelligence briefing of the area to be overflown. At 2200 (12 hours before planned take-off time) a review of the weather confirmed the mission was still on, so the pilots went to bed to ensure they got a full eight hours of 'crew rest'.

They awoke on the morning of the 31st to torrential rain, a new phenomenon to the 'desert dwelling' A-12s. The pilots ate breakfast, dressed and proceeded to prepare for the mission, despite the rain. Since weather conditions over the 'collection area' were good at 0800, Kadena received a final clearance from Washington that *Black Shield* flight X001 was definitely 'on'. (This first mission ought to have been designated BX6701 according to *Black Shield*'s system, but is quoted in official documents as X001.) Meanwhile, the rain continued without let-up, casting serious doubt over the launch. The pilots had the final say in the matter, since conditions were within Air Force take-off limits.

Mele, well aware of the pressure on the programme to deliver, elected to launch. After brief medical checks, Mele and Jack both donned their S-901 full pressure suits and began breathing 100 per cent pure oxygen to purge their bodies of potentially harmful nitrogen. By taxi time the rain was falling so heavily that a staff car had to lead Mele from the hangar to the

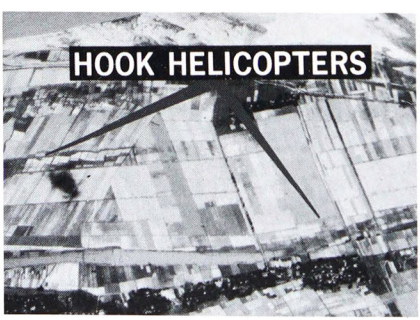


▲ This image has been analysed and annotated by the NPIC. It is part of frame 761 taken during BX6706, flown by Jack Weeks in Article 129 on 30 June 1967. (CIA via Robert Robarge)

▶ Taken from the earlier frame, this image clearly demonstrates how the fine film grain was able to capture such a large area and then enable enlargement sufficient for the extraction of relatively small details, in this case two Soviet-supplied Mil Mi-6 "Hook" heavy transport helicopters. (CIA via Robert Robarge)

end of the main runway. After lining up for what would be the A-12's first instrument-guided take-off, on cue, Mele engaged both afterburners and accelerated 131 rapidly down the runway, to disappear completely into the rain and then upward through the clouds.

A few minutes later he burst through cloud and up to 30,000ft to top off 131's tanks from a waiting KC-135 tanker. Disengaged from the boom he accelerated and climbed to operational speed and altitude, having informed Kadena that aircraft systems were running as per the book and the back-up services of Jack Layton wouldn't be required.



He penetrated hostile airspace at Mach 3.2 and 80,000ft during a so-called 'front door' entry over Haiphong, then continued over Hanoi before exiting North Vietnam near Dien Bien Phu. A second air

refuelling took place over Thailand, followed by another climb to speed and altitude, and a second penetration of North Vietnamese airspace near the demilitarised zone (DMZ). He recovered into Kadena after three instrument approaches in driving rain. In all, the flight had lasted 3 hours 55 minutes.

During an interview with the author, Mele claimed that several SA-2s were fired at the aircraft, but all detonated above and well behind their target. (This remains a matter of controversy, for when the CIA's Oxcart programme manager, John Parangosky, wrote his classified paper about the project under the pseudonym Thomas P. McInnch, shortly after its termination, he asserted that no hostile action was taken against any of the first seven missions.)

Back in the 'barn', the film from the 'photo-take' was downloaded and sent by a special courier aircraft to the Eastman Kodak plant in Rochester, New York for processing. The imagery was then sent to photo interpreters (PIs), at the National Photographic Interpretation Center (NPIC), located within the Washington Navy Yard. They used it to prepare an initial photographic intelligence report (IPIR). The results were astonishing. In all, Article 131's Perkin-Elmer Type 1 camera had successfully photographed ten priority target categories, including 70 of the 190 known SAM sites.

A roster was set up for the six operational *Black Shield* pilots on the basis that at least two would be required on station at Kadena at any time. Frank Murray recalls:

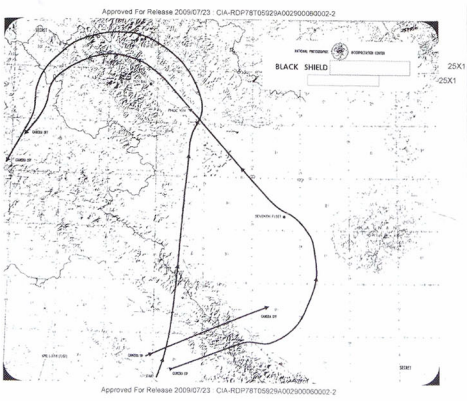
> We flew out to the OL on US-flag airlines, in business class, one guy at a time. Some allowance was made if a guy went on holiday and the like, and when it was time for one pilot to be replaced the new guy would fly in a week or two before the other left. We were all housed in an old Quonset Hut housing area called 'Morgan Manor'. The Agency had them overhauled and they were deluxe by anyone's standards, with a fresh coat of paint on the outside, but really well fitted out inside.
>
> A couple of good-sized portable buildings were joined to make the mess hall and offices and it was all located at the adjunct of a major intersection called Kadena Circle, near the base gates. The briefing room was situated on base, within a small fenced compound close to our hangar area. Also inside the compound the Agency had a very large log periodic antenna tower, used for their radio traffic and to monitor our Birdwatcher equipment – unfortunately a typhoon blew the first one down before the footings were cured!
>
> The usual build-up for a *Black Shield* mission at the OL started with a pre-notice. With only two pilots and three aircraft to support the mission, both pilots were alerted to be ready for a 'GO'. Most of our missions were over North Vietnam, so we'd usually receive the alert about mid-morning the day before the planned sortie. We then usually conducted a pre-brief consisting of a weather forecast in the general area of interest; the intel guys would go over the expected areas of interest and the expected defences we were likely to face if we were detected and acted upon.
>
> Our ground crews would be busy readying the aircraft, the selected camera system and other recording devices. We always readied two aircraft for South-East Asia missions. Both Oxcart pilots attended the briefings; one would be designated primary, the other standby, in case primary had to abort. The Agency was completely focused in ensuring the flight was 'on time' no matter what. From memory, I think that the back-up aircraft was ready to launch should primary abort any time up to completion of the first tanker top-off.
>
> The day of the sortie, we'd attend the mission briefing; also there was the Det Co and his assistant, the weather guy, an intel officer and the nav section guys, who

▲ In an attempt to capture SA-2 launches at the three Black Shield Oxcarts on film, a rear-facing camera was installed. This view is from an A-12 at cruise speed and altitude. (CIA via Frank Murray)

briefed the route of flight and where our tanker support would be. We were then told a special little bit about where we could expect help if we were downed – I don't think any of us had too much faith in this part of the briefing. This entire final briefing took no more than an hour to complete, then we were off to the suit room and have a little physical examination so that the flight surgeons could verify that we were still alive! I was never told if at this point they detected a slight increase in our blood pressure. Then the crew bus delivered us to the hangar; we'd get in and get on with it.

During the first three months of *Black Shield* operations, nine missions were successfully completed. One of those 'alerted' but subsequently aborted was to be Jack Layton's first operational flight. All had gone well until he entered the Deep Work refuelling track, just southwest of Okinawa, and hooked onto the KC-135Q's refuelling boom. The boom operator's first remark as the A-12's fuel tanks began to fill was, 'You don't want to go supersonic with this aircraft, sir.' The puzzled A-12 pilot enquired why, as there were no cockpit indications that supported such a remark and the aircraft seemed to be handling well. 'I don't think you'll want to go fast, sir,' the boomer insisted, 'because the left side of your aircraft is missing.' After further consultation with the boom operator and other tanker crewmembers who went aft to view the unusual sight, Jack decided that prudence should dictate he abort his first important mission, however reluctantly.

▼ This map prepared by the NPIC is part of the analysis report compiled after BX6709, piloted by Dennis Sullivan in Article 131 on 19 July 1967. It shows the three tracks flown during the mission, the second of which captured the 7th Fleet. The third exited back to Kadena via the DMZ. (National Archives via Lin Xu)



As he turned back to Kadena, an F-102 interceptor was scrambled from Naha AB, Okinawa to serve as escort in the event of controllability problems. As the Delta Dagger drew alongside the crippled Cygnus, the F-102 pilot reported that the A-12 had lost practically all its left chine panels from nose to tail. In addition, large panels on the wing uppersurface (which also covered the top side of the wheel well) had disappeared, allowing the escort pilot to see right through part of the aircraft's left wing. As some of these panels had broken loose, at least one had impacted the top of the left fin, causing even more damage.

As the two aircraft descended below 20,000ft, they dipped into clouds and the A-12's cockpit fogged up so badly Jack was unable to see his hand in front of his face,

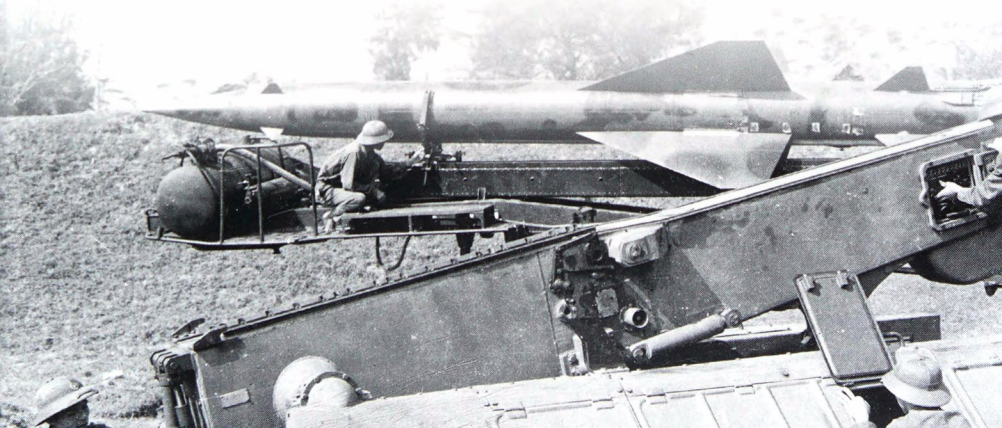
let alone read his flight instruments. He quickly called for the F-102 pilot to report the A-12's attitude, since he was becoming very concerned that it might depart its flight envelope by stalling or diving. Relieved that he had remained within normal flight parameters, Jack managed to climb back out of the clouds. By turning the cockpit temperature control to full hot, he managed to eliminate the humidity that had caused the fogging, but the hotter-than-normal cockpit soon became extremely uncomfortable. Nevertheless, he was able to safely recover back at Kadena without further incident.

According to Parangosky, mission BX6705, flown by Jack Layton in Article 127 on 20 June 1967, marked the first occasion on which an A-12 was successfully tracked by enemy radar. Bearing in mind the time and money that had been invested in reducing the aircraft's RCS, this must have caused considerable consternation at project headquarters in Washington and Burbank.

By mid-July, *Black Shield* imagery had determined with a high degree of confidence that there were no surface-surface missiles in North Vietnam. But Oxcart flights were becoming invaluable, providing important intelligence to mission planners about the enemy's order of battle, as well as high-quality bomb damage assessment (BDA) imagery. The problem was the protracted timelines involved in processing the intelligence from film download to receipt of the processed imagery and the IPIR.

To speed up the process, the 67th Reconnaissance Technical Squadron (Recce Tech) at Yokota AB, Japan, was provided with the necessary skills and equipment to undertake the work. So, following an enormous amount of hard work and dedication, on 18 August 1967 the 67th RTS was recertified as Overseas Processing and Interpretation Centre-Asia (OPIC-A). Now theatre commanders had *Black Shield* imagery and an IPIR within 24 hours of a mission. From mission BX6722, flown by Jack Weeks in Article 129 on 16 September 1967, this became the standard operating procedure (SOP) throughout the remaining period of *Black Shield*.

From September to the end of December 1967, the three *Black Shield* A-12s completed 13 operational missions, the highest period of activity being reached in October, when seven sorties were flown. Frank Murray's first operational mission, BX6727 (a so-called 'double-looper'), was flown on 6 October in Article 131. Frank commenced his first photo run at an altitude above 80,000ft on a track deep into North Vietnam with all systems functioning well. But as he was about to turn off his cameras before heading south toward Scope Pearl, the air refuelling track in Thailand, his left engine started vibrating, followed shortly thereafter by a



▼ A North Vietnamese Army SA-2 battery reload. (Alberto Grandolini via Thomas Newdick)

▲ BX6732 imaged an SA-2 site with four launchers, each mounting a missile. (National Archives via Lin Xu)

left inlet unstart. Frank recalled:

I had my hands full for a while. In fact, I ended up having to shut the engine down. I increased power on the good engine and flew it at maximum temperature for about an hour before I hooked up with the tanker. Because of the shutdown engine, I decided to divert into Takhli and the tanker crew relayed massages back to Kadena that I was diverting. Because I kept my radio calls to a minimum for security reasons, I didn't identify myself to the Takhli air traffic controllers until I was on final approach for landing.

I landed (after just 2 hours 20 minutes) without incident, but inadvertently screwed up a complete F-105 strike mission launch when I jettisoned the big brake 'chute on the main runway. I turned off the runway and sat there with the engine running and asked that the base commander come out to the aircraft as there were certain things I had to tell him. My presence was causing a pandemonium of curiosity; there was this most unusual black aircraft with no markings, the like of which nobody on that base had ever seen before, which had dropped in completely unannounced, disrupting a major operation and its pilot insisting on the base commander coming out to see him! While this was going on, guys on base with cameras were clicking away like mad. Eventually they sent out the Thai base commander, which was no good because I wanted the US base commander. He eventually arrived and (despite all my disruptions to his war operations) was extremely helpful.

After Frank's aircraft had been safely tucked away in an Agency U-2 facility on the base, the Air Force security police had a field day confiscating the opportunists' film. An inspection of the left engine revealed that most of its moving parts had been 'shucked like corn from the cob' and were lying in the tailpipe and afterburner. A recovery crew flew in a spare engine, but Article 131 had also sustained notable damage to the nacelle and some of its nearby electrical wiring. It was decided that the jet would have to be flown back to Kadena 'low and slow' on 9 October. Frank explained: 'I got airborne and headed off south over the Gulf of Thailand, where I picked up an F-105 escort that led me out over South Vietnam. An escort of F-4s then covered me and my tanker, before breaking off to return to their base. We then made our way via the Philippines, where I picked up another tanker, which led me back to Kadena.'

▼ Fired upon by a single SA-2 on 28 October, Dennis Sullivan (Stateside call sign Dutch 23) had an extremely lucky escape two days later. (CIA)

While Frank was dealing with the inflight emergency over North Vietnam, his attention had been diverted away from switching off the photographic equipment to the more pressing priority of controlling the aircraft. As he turned south, his camera had taken a series of oblique shots into China.

Close analysis of those photos revealed eight tarpaulin-covered objects among a mass of other material along the large main rail link between Hanoi and Nanking. Further photo interpretation ascertained that the 'tarps' were flung over rail flatcars in an attempt to hide 152mm self-propelled heavy artillery pieces. A great mass of other war materiel in the rail yards had been assembled for onward movement to North Vietnam during the oncoming winter season, when low clouds and poor visibility would hamper US bombing

efforts to halt south-bound supply lines. A timely and highly valuable piece of strategic intelligence, gained on the back of Frank's troubled sortie, had delivered a unique opportunity to track the further movement of those guns and supplies, which were obviously intended for use in future offensive actions.

DET F-101s AND MORE MISSIONS

Two F-101s from Area 51were deployed to Kadena as part of *Black Shield*. There they provided detachment crews with proficiency training. One of their number was lost, together with its pilot, Walt King, the detachment weather officer, when it crashed immediately after take off – the aircraft was never replaced.

During sortie number BX6732, flown in Article 131 by Denny Sullivan on 28 October 1967, the pilot received indications on his RHAW display of almost continuous radar activity focused on his A-12 while inbound and outbound over North Vietnam. This culminated in the launch of a single SA-2 – according to Parangosky, the first ever at an Oxcart.

Two days later, on 30 October, during the course of sortie BX6734, Sullivan was flying Article 129 high over North Vietnam on his first eastbound pass, between Haiphong and Hanoi (logged in Agency analysis documents as pass 34A), when his RHAW receiver display indicated that two SA-2 sites were tracking him and preparing to engage, but neither launched.

During the second pass, heading west and in the same area as earlier (pass 34B), he again noted that he was being tracked on radar; over the next few minutes all hell broke loose and he counted at least six SA-2 detonations. This turned out to be the most determined attack ever on a 'Blackbird'.

Not surprisingly, a full report on the attack was compiled by John Parangosky, who at the time was Acting Director of Special Activities, and it was made available to the CIA's DDS&T. Classified Top Secret, it represented the coordinated views of the OSA, OSI and Office of ELINT. The investigation and its findings are well worth recording, as they provide a fascinating insight into not just the Agency's ability to draw together various intelligence-gathering disciplines, but they also demonstrate the ability of Oxcart's Defensive Electronic System (DEF) and, equally, the determination of the North Vietnamese to 'bag an Oxcart'.

First is an extract from Denny Sullivan's debrief report: 'The missiles were in a deep climb through the aircraft altitude of approximately 83,500ft, then they made a sharp push over to a moderate dive angle, levelled out at my altitude and guided toward the stern of the aircraft to detonate. The missiles varied slightly in azimuth compared to my line of flight in their climb, but all corrected in azimuth to an accurate dead stern position during push over and dive phase. [Missile altitude] estimated 90,000ft is probably quite close, but could vary a few thousand feet either way. It was not possible to view the entire contrail until down track a few miles due to narrow angle view in the rear periscope.' (In this encounter the pilot was referring to three missiles.)

The report adds, 'Additionally, the pilot reported observing a missile approximately 100 to 200 yards to the right of the aircraft abeam the cockpit. It was in a 70 to 80° climb angle in the direction of aircraft flight. The missile was reported to have been rotating fairly fast about its vertical axis and appeared to the pilot to be the last detonation to be observed, as quoted in the paragraph above. In summary, the pilot felt that he saw at least six missile contrails and three detonations, all to the rear of the aircraft.' The report states that at least seven and possibly as many as ten SA-2s were fired at Article 129. It notes the intensity of enemy activity on the second pass, during which Sullivan was attacked, as recorded by the aircraft's ELINT system:

▶ This sequence of frame grabs, believed to have been taken from 16mm footage shot by the CIA's station head of security, shows a Black Shield A-12 taxiing from its hangar and getting airborne at Kadena AB – note the bogus serial '77358', applied in red on the tail to confuse aircraft 'spotters' at the perimeter fence. (CIA via Toni Hiley)

Approximately 60nm west of Hanoi the System VI [ELINT gathering equipment] indicated the presence of "Fan Song" low-PRF signals. Subsequently, System VI indicated the following activity:

0454:33Z - FAN SONG up Low PRF
0454:37Z – FAN SONG down Low PRF
0454:43Z – FAN SONG up Low PRF
0456:11Z – MAD MOTH Jammer up
0456:11Z – L-Band guidance 'A' up
0456:13Z – L- Band guidance 'B' up
0456:12Z – MAD MOTH responded to a dense concentration of high and low PRF FAN SONG signals emanating from at least six SAM sites until 0457:58 when the aircraft was approximately 15nm to the east of Hanoi.
0456:18Z – BLUE DOG 'A' up (associated with L-Band guidance 'A')
0456:21Z – BLUE DOG 'B' up (associated with L-Band guidance 'B')
0456:28Z – BLUE DOG 'C' up
0456:30Z - Numerous L-Band guidance signals
0456:30Z – BLUE DOG 'D' up
0456:41Z - BLUE DOG 'E' up
0456:43Z – BLUE DOG 'F' up
0457:12Z – BLUE DOG 'B' down
0457:16Z BLUE DOG 'C' down
0457:18Z – BLUE DOG 'D' down
0457:29Z - BLUE DOG 'F' down
0457:38Z - BLUE DOG 'E' down
0457:58Z – MAD MOTH down
0458:54Z – BLUE DOG 'A' and L-Band 'A' guidance down
0459:49Z – FAN SONG Activity ceased.

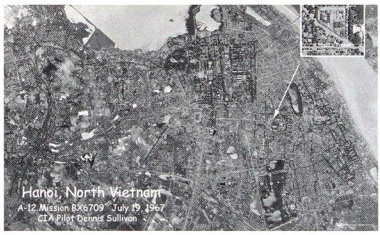
From COMINT the report noted, 'During the period 0455Z to 0459Z, COMINT reflections of pass 34B indicated that SAM battalions of two regiments (Phuc Yen and Hanoi) were actively tracking and attempting launches on the *Black Shield* vehicle. COMINT indicated that the SAM battalions located at sites #324, #133, #142, and at least two other un-located sites were active during this time.'

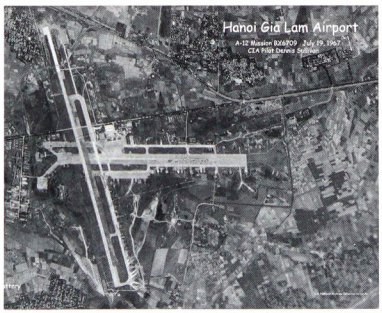
From photography captured on the film carried by Article 129's Perkin-Elmer Type 1 camera, the report established 'that 13 SA-2 sites were occupied. Analysis of six SA-2 vapour trails which appeared in photography taken from 0457:04Z to 0457:18Z indicated that sites #234, #244, #133, and a newly identified site located west of Hanoi launched a total of five

missiles in the direction of the *Black Shield* vehicle. No information could be obtained from the sixth vapour trail that would indicate its launch site. Additional photography of sites #14 and #142 indicated that several launchers (3 and 2 from #14 and #142 respectively) and their FAN SONG radars were pointed in the direction of the *Black Shield* vehicle. Analysis of all the data indicates that sites #234, #133, #142, #14, #244 and the new site were active and most probably launched six to nine missiles at the aircraft.'

The report concluded that analysis of System VI indicated that the aircraft's DEF system performed as designed in jamming a multi-signal environment. The report detailed a total of four significant findings that are worth quoting in full:

a) Although not readily apparent it appears that the Low-PRF launch mode was employed on at least the first two firings of pass 34B. The signal density following these launches precludes any statements regarding Low-PRF launch of the other firings.
b) The guidance computer recycle time of 55 seconds has apparently been extended or the clock removed from the system, as evidenced by the duration of L-Band guidance signals (34A, 61 seconds – 34B, 163 seconds).
c) Spoof and/or saturate EW systems – The duration of the L-Band signal of pass 34B (163 seconds) and the nature of the guidance commands (unrealistically small for an intercept of the vehicle) indicate there may have been an attempt to spoof the BLUE DOG jammer. Also, NPIC analysts indicate that within the limits of their photography of BX6734 there was a heavier than usual concentration of occupied SAM sites in the Hanoi area. Furthermore, *Black Shield* photography did not reveal any occupied sites in the Haiphong area. It may be that SAM battalions were moved into the Hanoi area from other areas specifically in an attempt to concentrate fire on a repetitive area of *Black Shield* routes. This enhanced, as far as the Soviets/Vietnamese may have concluded, their ability to saturate MAD MOTH.
d) Relevant findings resulting from the pilot's comments: The pilot reported a missile rotating fairly





▲ BX6709's Type 1 camera captured the notorious North Vietnamese POW camp Hoa Lo, known by its US inmates as the 'Hanoi Hilton'. (National Archives via Lin Xu)

◀ In addition to updating the US intelligence community's knowledge of the airfield at Gia Lam, BX6709 also located an active SA-2 battery in the vicinity. (National Archives via Lin Xu)

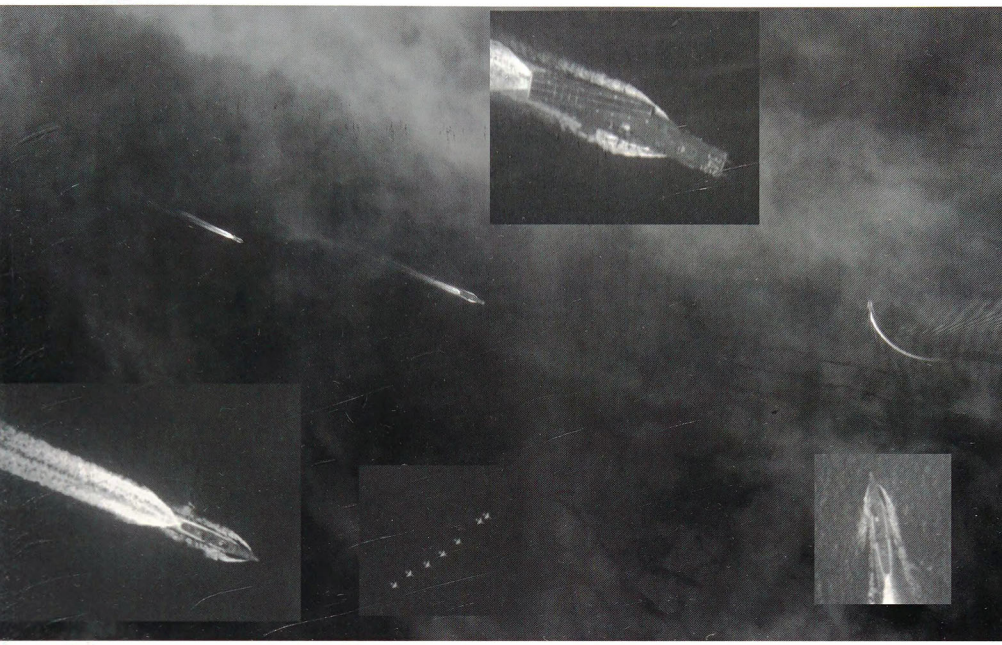
▲ BX6709 imagery shows part of the 7th Fleet. The arrows point to the position of US Navy aircraft. (National Archives via Lin Xu)

> fast about its vertical axis approximately 100–200 yards to the right of the aircraft and abeam the cockpit. The SA-2 Mod I missile rotating about its longitudinal axis is a missile out of control and will no longer answer to any guidance commands. It seems extremely unlikely that an out of control missile could perform a 'push over', dive and correct in azimuth to a dead stern position. It appears to be more probable that the pilot observed two different missiles; one climbing abeam of the aircraft, and another detonating some few seconds later to the rear of the aircraft. Although the rotation of the missile about its longitudinal axis may have been caused by the on-board jammers; it is not possible at this time to positively state that this was the actual cause of rotation.

From the analysis, it was deduced that the increased launch range capability of the Democratic Republic of Vietnam (DRV) SA-2 system in low PRF would definitely increase the kill probability under conditions of Oxcart jammer malfunction. However, it considered that this increased capability against an Oxcart with a fully operational ECM system was still 'essentially zero'.

With 129 recovered at Kadena without further incident, a post-flight inspection revealed that a tiny fragment of debris from the missile, but not from its warhead, had penetrated the aircraft's right aft fillet and lodged in the support structure surrounding the number five fuel tank. Six missiles were positively identified as having been fired at the Oxcart. Each had a warhead packed with 3,600 'pellets', for a total of 21,600, and not one had managed to hit 129. History would record the missile fragment as having caused the only 'damage' ever inflicted by an enemy on a Blackbird.

The North's missile activity caused DCI Richard Helms to order the temporary suspension of *Black Shield* flights, during which time those involved were given the opportunity to review



▲ Enlargement of the 7th Fleet image shows two escort vessels and USS *Oriskany* (CV 34 – note the number on the carrier's foredeck), and seven A-4E Skyhawks awaiting clearance to land. (National Archives via Lin Xu)

and re-evaluate procedures and routes. In fact it was more than a month before operational flights resumed, and their reintroduction saw a temporary switch of target area; for the first time, the collection area was Cambodia.

Black Shield missions BX6737 and 6738 both used Article 131 and were flown by Mel Vojvodich on 8 December 1967 and Jack Layton two days later. During the first four-hour sortie, cloud cover obscured four of seven special search areas in which troop concentrations had been expected in the extreme northeast of Cambodia; they included both primary targets, although limited troop activity at the point where the Tonle San River crosses the Cambodia/Laos border was detected, together with the re-grading of the natural surface runway at Ban Pania airfield.

In contrast, the virtually cloud-free conditions experienced by Jack Layton on 10 December enabled his Type 1 camera to gather valuable photography on all seven priority search areas – although not without incident. As Jack recalled, the INS caused the aircraft to overshoot the planned track during turns, causing him to 'penetrate the bamboo curtain' into North Vietnam. After turning south and getting back to an approximate course toward Scope Pearl, he had difficulty finding the tankers due to thick cloud and poor visibility.

'I got the aircraft up in a bank to search for the tankers, but the visibility from an A-12 is very poor; you can look down and see the ground but you can't look inside the turn because of the canopy roof. I'd just about reached the point where I was about to divert to Takhli due to the lack of fuel when I finally saw the tankers. We got together and I was able to complete the mission even though the INS wasn't working.'

On 15 and 16 December, overflights of North Vietnam resumed. To limit exposure to the SA-2 risk, mission planners re-orientated the route, moving the track from an east/west direction to a less productive south/north route. The next two missions, BX6739 and 6740

both adhered to the amended route and no SA-2s were fired. However, when Jack Layton flew BX6842, reverting back to the earlier east/west route on 4 January 1968, he was attacked by a single SA-2, again during the second pass. On this occasion, the missile was launched with its "Fan Song" missile control radar in low PRF. The aircraft's ECM equipment, Mad Moth and Blue Dog, was activated and the missile missed its target.

As 1967 drew to a close, 41 *Black Shield* missions had been alerted by project headquarters, of which 22 were actually flown. Between 1 January and 31 March 1968, 17 missions were alerted, of which seven were flown, four over North Vietnam and three over North Korea. The main reason why flights were scrubbed having been scheduled was poor weather conditions in the collection area.

TARGET, NORTH KOREA

In a CIA document classified Top Secret, but approved for release in June 2002, the rationale was outlined for Oxcart reconnaissance missions against North Korea. It stated that the belligerent pronouncements by North Korean civil and military leaders and an increase in the number and expanded scope of North Korean probes along the DMZ, coupled with its efforts to establish the structure for guerrilla operations in the South, had established a critical requirement for accurate intelligence.

It further noted that satellite photos had not provided adequate imagery of North Korea to satisfy the requirement, and that ground collection of this intelligence was becoming increasingly difficult; taken together, this had made an accurate estimate of capabilities and intentions all but impossible. It continued that the operational concept could now be accomplished on a 24-hour alert basis, using *Black Shield* assets in place at Kadena, without coverage degradation of targets in North Vietnam.

Three passes traversing the target areas east to west or west to east could be accomplished with two air refuellings, or two passes of similar orientation could be executed with a single air refuelling. All routes provided flexibility to adjust photographic flight lines to meet changing weather and/or target requirements. It further noted that penetration of denied territory would be accomplished at 76,000ft or above at Mach 3.1. Emergency or missed air refuelling divert bases would be in South Korea, but in all other circumstances launch and recovery would be from Kadena.

In the document's air defence analysis it notes that there were 13 known SA-2 sites in North Korea, and that as no airborne jamming would be undertaken by other US airborne assets, the threat of a possible SAM reaction from North Korean SA-2 systems was deemed greater than in the skies over North Vietnam. For this reason, Oxcart flight over SAM-defended areas of North Korea was to be conducted above 80,000ft and at a speed of Mach 3.2 to provide maximum protection. It also noted that there were 30 or more Soviet SA-2 C-band and possibly S-band sites in the Vladivostok area, the furthest known sites to the south of this enclave being approximately 75 miles from the North Korean border.

In relation to the airborne threat, it stated there were no aircraft in the North Korean air order of battle that were a threat to Oxcart; however, it noted that the Soviet "Firebar" had an intercept capability against the A-12 and that 21 such aircraft were based at Spassk Dalnij East, approximately 175 miles from the closest Oxcart flight path and 125 miles north of the North Korean border.

In summary, it concluded that although a somewhat higher total threat potential existed for the proposed mission compared to North Vietnam, the surprise element could well prevent an effective response, particularly during early sorties. In a final point, especially in

relation to any 'incidents', it noted that in the event that any such sortie required implementation of an official contingency, the aircraft would be described as an unarmed reconnaissance aircraft, engaged in surveillance of activities in the demilitarized zone between North and South Korea and that intentional overflight of North Korea would be denied.

On a footnote, at the bottom of a sample route map, it added that photographic resolution would be in the order of 1ft to 3ft 6in., and that two eastbound and one westbound pass over the North would take just 17 minutes to complete. Despite this, the US State Department vetoed the plan.

In late 1967 DCI Richard Helms requested the Committee on Imagery Requirements and Exploitation (COMIREX) to prepare a briefing document concerning reconnaissance of North Korea. Two earlier pieces of work in this regard had been carried out (including one by the Commander, US Forces Korea) and the other by the Board of National Estimates, which had recommended 'increased efforts in the collection and analysis of political, economic and military information, particularly on the subjects of North Korea intentions toward the South.'

The Top Secret COMIREX memo, dated 9 October 1967, drew reference to both of these earlier recommendations and also made reference to other reconnaissance assets that had been available for use against North Korea, including, in subsection A of paragraph 3, KH-4 [satellite] Mission 1101 during the period 21–28 September 1967, which had provided usable photography of more than 85 per cent of North Korea and, in subsection C of the same paragraph, 'U-2 – North Korea was last covered by the U-2 Tackle program on 31 July 1965. The program is currently stood down; but even if a U-2 mission were attempted against North Korea, it would now have only limited access because of the SAM sites which protect much of the interior of the country'.

The memo ended by observing that *Black Shield* could, subject to weather, provide the necessary coverage of the country within a short period of time and that this would be of 'substantial assistance in correcting the intelligence deficit on the North Korean military posture and in providing a new baseline against which to check other intelligence as may be available.' Yet again, no immediate action was taken.

THE *PUEBLO* AFFAIR

In an April 1965 intelligence planning meeting, it had been decided to establish a small fleet of signals intelligence ships similar to the Soviet fleet of 40 such vessels that operated near the United States and in many other strategic points around the world. The decision received prompt approval from Director of Defence Research and Engineering, Dr Harold Brown, and from Deputy Secretary of Defence Cyrus Vance, for the implementation of a two-phase plan.

In Phase One, USS *Banner* was transformed into Auxiliary General Environmental Research Ship 1 (AGER-1) and duly steamed out of Washington State's Puget Sound Naval Shipyard on the first of its planned 16 sea patrols in the western Pacific. Meanwhile, two Army supply ships, *FS-344* and *FS-389*, were re-christened as USS *Pueblo* (AGER-2) and USS *Palm Beach* (AGER-3). By 1 December 1967, the extensive modification programme was complete and *Pueblo* joined *Banner* in Yokosuka Harbour, Japan. By then, *Banner* was a veteran on intelligence surveillance

▼ USS *Pueblo* (AGER-2) and its crew became the focus of a major international incident when it was boarded and captured by North Korea. (US Navy)

▶ Jack Weeks (Stateside call sign Dutch 29) completed BX6847 on 26 January 1968, a mission that located the beleaguered USS *Pueblo*. (CIA)

▼ USS *Pueblo* caught by Article 131's Type 1 camera. (National Archives via Talent-Keyhole.com)

duties. While at Yokosuka, a six-month schedule was drafted covering nine separate missions, five of which were tasked by the NSA.

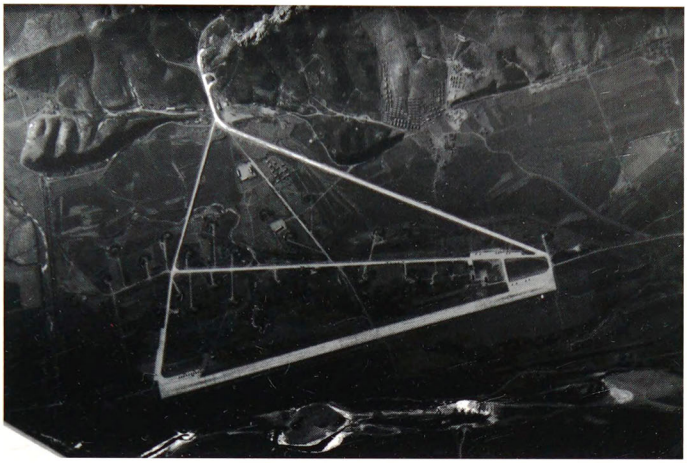
The *Pueblo*'s first sortie was tasked by the US Navy and called for the ship to 'sample the electronic environment off the east coast of North Korea' and to 'intercept and conduct surveillance of Soviet naval units operating in the Tsushima Straights.' The risk estimate was assessed as 'minimal'. A request for final approval was contained in the 'Monthly Reconnaissance Schedule for January 1968', maintained by the Joint Chiefs of Staff's Joint Reconnaissance Center (JCS-JRC). On 29 December 1967, approval was received from the proper agencies (JCS, CIA, NSA and the State Department) and from officials (Deputy Secretary of Defence Paul Nitze and the NSC's 303 Committee).

On 5 January 1968, the unprotected *Pueblo* sailed as ordered on its maiden voyage for the east coast of a belligerent nation, North Korea. On board was a crew of six officers, two civilians and 75 enlisted men. Just 18 days later, during the night of 23 January, the ship's radio operator managed to get off an emergency signal. 'We Need Help! We are Holding Emergency Destruction! We Need Support! SOS. SOS. SOS. Please Send Assistance! SOS. SOS. SOS. We Are Being Boarded!' The last sentence clearly stated what was happening aboard the beleaguered vessel, and with one sailor dead and the rest of the crew captured, a year-long nightmare for Lt Cdr Lloyd Bucher and his crew was just beginning.

In response to the incident, President Johnson summoned his top advisors to a meeting at the White House the very next day (24 January) to agree a course of action. Later that day, DCI Richard Helms dispatched a top secret memo to Special Assistant to the President Walt Rostow, Secretary of Defence Robert McNamara, Under Secretary of State Nicholas Katzenbach, Deputy Secretary of Defence Paul Nitze, and Chairman of the JCS Gen Earle Wheeler, in which he referred to the earlier meeting and confirmed that he was 'alerting an Oxcart mission for photo reconnaissance of North Korea'.

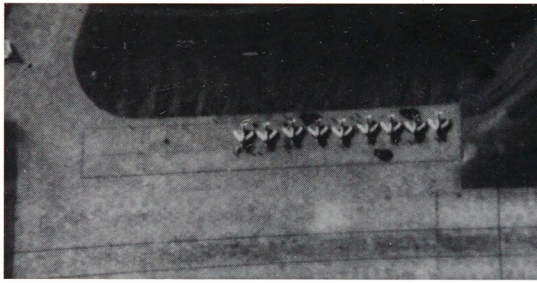
It continued: 'The Oxcart mission has been alerted to take off [deleted] on 25 January at 2100 EST (1100/26 January [deleted]) and return four and ½ hours later. The film will be off-loaded immediately and airlifted to Eastern Kodak, Rochester, New York, to arrive at approximately 0430 EST on 27 January. The processed film will be delivered immediately to NPIC with an arrival time of 1440 EST on 28 January.' Point 3 in the memo noted: 'The weather forecast for this mission indicates Category II (25 per cent or less cloud cover) weather conditions for the target area.' Finally, point 4 noted: 'No additional resources or support over and above those normally used on Oxcart North Vietnam operational sorties will be required for this mission.'

In total, three A-12 sorties were flown as a consequence of the capture of the *Pueblo*. The first of these was BX6847, flown on 26 January 1968 by Jack Weeks in Article 131, just 24 hours after the ship was captured. The Oxcart was equipped with the Pin Peg, Mad Moth and



◀ In addition to its primary target, BX6847 also imaged several North Korean airfields. Note at the top of the image how the taxiway disappears into a cliff face, and the MiG-17s on the apron. (National Archives via Talent-Keyhole.com)

▼ A more detailed look at the MiG-17s. (National Archive via Talent-Keyhole.com)



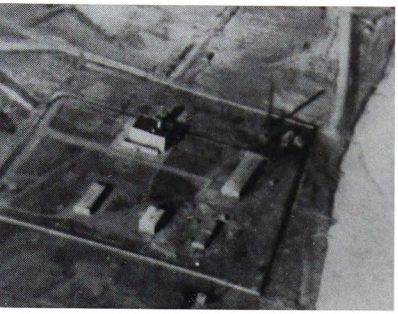
Blue Dog II ECM suite, System VI ELINT recorder and Type 1 camera. *Pueblo* was located at anchor some distance from Wonson Bay, and despite a right engine inlet unstart on the third pass, Jack's four-hour sortie was a spectacular success, helped by the fact that 90 per cent of North Korea was cloud free.

Just three days after Jack Week's highly successful mission, Lt Gen Joseph Carroll, Director of the NRO, fired off a memo to the Chairman of the Joint Chiefs of Staff, noting the following:

1. CINCPAC [Commander-in-Chief Pacific] and the Defence Intelligence Agency have conducted independent assessments of photography acquired by BX Mission 6847, flown over North Korea on 26 January. From these assessments, it has been determined that while much valuable photography and information were obtained, major deficiencies in our intelligence holdings still remain in the following target categories:

a) Jet Capable Airfields: Current overhead photography is still required of seven major jet capable airfields in North Korea. Included is the important Il-28 bomber base at Uiju, which is the normal operating base for a majority of these aircraft. Of 80 Il-28s currently estimated in the North Korean inventory, only 12 were located by the 26 January mission. The seriousness of this coverage gap was further aggravated [text redacted – remains classified].

b) Naval Order of Battle: Coverage was not acquired of the naval facility at Mayang Do, which normally serves the North Korean submarine fleet, nor was coverage of several key naval bases in north-eastern Korea. The requirement for current naval OB [order of battle] information was emphasized by the identification of three "Komor"-class guided missile patrol boats on the recent BX mission. These boats, which were



▲ Almost 30 miles from BX6847's track and at a ground resolution of 2–3ft, this is Yongbyon, North Korea's nuclear plant. (National Archives via Talent-Keyhole.com)

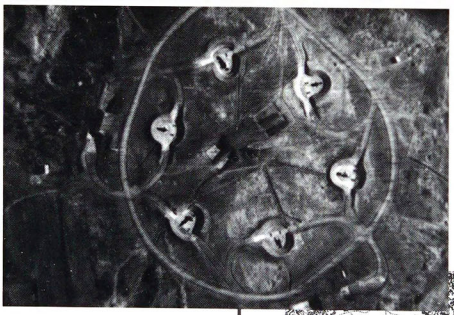
observed at Wonsan, increased our estimate of their holdings to seven. Coverage of the important naval bases in the northeast, therefore, is required to ensure our awareness of any important changes to North Korean naval OB in that area.

c) Ground Force Activity: Additional high-resolution photography of the areas covered by the 26 January mission is essential to our continued military awareness of significant changes to ground force OB and related installations and activities. In addition, reconnaissance coverage of the North Korean border area adjacent China as well as most of the north-eastern segment of North Korea is still required to establish a high resolution database by which to measure military activities in these areas.

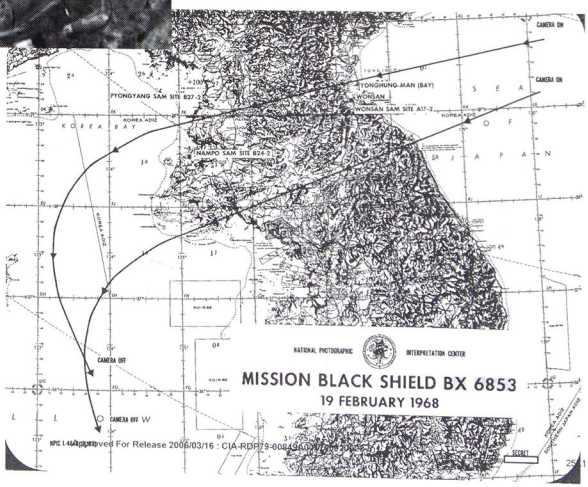
2. In order to satisfy the outstanding requirement outlined above, CINCPAC has specifically and urgently requested that an additional *Black Shield* mission be flown over North Korea. Based upon an assessment made within the Defence Intelligence Agency, I concur in the CINPAC position and recommend that the Joint Chiefs of Staff indorse this requirement and seek authority for additional *Black Shield* reconnaissance of North Korea.

However, US State Department officials were extremely wary of endorsing a second mission over North Korea after the *Pueblo* event. The diplomatic wounds left by the 1960 Powers' incident were still sensitive eight years after the event. It wasn't until Brig Gen Paul Baclais had briefed Secretary of State Dean Rusk on the specific mission objectives and assured him that the aircraft would only be in North Korean airspace for seven minutes (two passes, or 'photo lines') that the State Department gave its blessing.

Consequently the three-hour 39-minute BX6853 sortie was flown in Article 127 by Frank Murray on 19



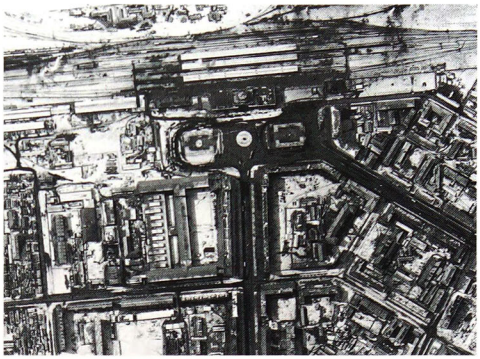
▲ Also recorded were 13 SAM sites, 12 of which were occupied. (National Archives via Talent-Keyhole.com)



▶ BX6853 was the second A-12 overflight of North Korea. (National Archives via Lin Xu)

February 1968. It employed the same sensor as the previous incursion and found 88 per cent of the programmed targets cloud free, but this proved not to be the case where *Pueblo* was concerned, and it remained hidden from 127's Type 1 camera.

On 6 May 1968, Jack Layton launched Article 127 on sortie BX6858 and headed out on the A-12's third mission to North Korea. Unknown to him at the time, his mission was the final operational flight of the Oxcart programme. The sortie experienced a moment of tension when Jack was on his way back to Kadena; after a high-speed phase, 'milky white fingers' began slowly clawing their way across the windscreen. Having already experienced this 'white-out' phenomenon to a lesser degree during a stateside training sortie, Jack was aware of the problem, which was caused by frictional heating on the windscreen to the point that the glue between glass laminations became viscous and turned completely opaque. Proceeding on instruments all the way to landing, Jack completed a successful ground-directed radar approach for a safe recovery back to Kadena after three hours 30 minutes in the air.



▲ Pyongyang railway station imaged during BX6853. (National Archives via Lin Xu)

Although the procurement of such intelligence information was not of direct benefit to Lt Cdr Bucher and his crew, who were beaten and held captive for almost a year, such a 'hot-spot, quick-look' capability was considered an important achievement of the Oxcart programme, clearly demonstrating the ability of manned reconnaissance vehicles to respond with minimal lead times to international incidents of political and military importance. At the same time, the *Pueblo* incident ended the Navy's seaborne foray into ELINT trawling, the two remaining AGERs being scrapped soon after *Pueblo*'s seizure.

OXCART CLOSEDOWN

It is ironic that during the very month Oxcart was finally declared operational (November 1965), before the programme had had the opportunity of fully vindicating itself, moves were afoot to close it down. It was during that month that a memorandum was circulated within the BoB expressing serious concerns at the costs of Oxcart and Senior Crown (the SR-71 programme).

The memo challenged the need for the number of high-performance aircraft and doubted the necessity for separate 'covert' CIA and 'overt' USAF operations. Its writer proposed several less costly alternatives, recommending that the A-12s be phased out by September 1966 and that all further procurement of SR-71s should stop. Copies of the memo were circulated in certain circles within the DoD and CIA, together with a suggestion that they explore the alternatives set out in the paper. Since the SR-71 was not scheduled to become operational until September 1966, SecDef McNamara declined the proposal.

In July 1966, BoB officials proposed that a tri-agency study group be set up to establish ways of reducing the costs of the two programmes. In addition to budgetary considerations and politics, differing capabilities between the A-12 and SR-71 further complicated the decision making process. The A-12 was lighter and therefore could fly higher than its Air Force stablemate. Additionally, its cameras provided superior ground resolution to those being carried by the SR-71. However, the Air Force countered that in addition to carrying cameras, its platform mounted sensor packages, enabling it to undertake simultaneous

▲ Oxcarts awaiting storage on arrival at Palmdale in 1969. (Lockheed Martin via Tony Landis)

synoptic coverage of a target area by recording ELINT and, using its powerful ground mapping radar system, radar intelligence (RADINT).

In an attempt to resolve the dichotomy, a fly-off, code-named Nice Girl, was staged between the two types over the period 20 October to 3 November 1967. An example of each flew three identical routes along the Mississippi River. Representatives from a number of interested agencies then evaluated the data collected, but the results were inconclusive. With the study complete, a meeting was convened on 12 December 1966, and a vote taken on each of the three alternatives that had been proposed:

1) To maintain the status quo and continue both fleets at current approval levels;
2) To mothball all A-12 aircraft, but maintain the Oxcart capability by sharing the SR-71 between SAC and the CIA;
3) To terminate the Oxcart fleet in January 1968 (assuming an operational readiness date of September 1967 for the SR-71), and assign all missions to the Air Force SR-71 fleet.

Three out of four votes cast were in favour of option three. The BoB's memorandum was transmitted to President Johnson on 16 December, despite protestations from the CIA's Richard Helms, who was the sole dissenting voice in the vote. Twelve days later, Johnson accepted the BoB's recommendations and directed that the Oxcart programme be terminated by 1 January 1968.

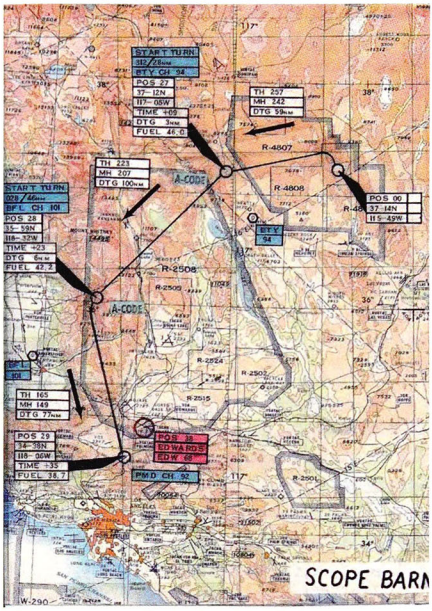
However, as the war in Vietnam escalated and the results of *Black Shield*'s outstanding work were made available to a privileged few, the wisdom of the phase-out decision was called into question. As a result, the run-down lagged and the debate re-opened. A new feasibility and cost study of Oxcart was completed in the spring of 1968, and despite the continuing objections raised by Richard Helms, the original decision to terminate the programme was reaffirmed on 16 May 1968 by the Secretary of Defence; the decision was further endorsed by President Johnson five days later, during his weekly luncheon with his principal advisors.

Project officials decided that 8 June 1968 would be the earliest date to begin the redeployment from Kadena back to the States. During the intervening period, sorties would be restricted to those essential for maintaining flight safety and pilot proficiency. Those aircraft

back at Area 51 were to be flown to Palmdale and placed in storage by 7 June. Meanwhile, at Kadena preparations were made for the A-12 ferry flights back to the United States. Mission sensors were removed for the final time and low-time/high-performance engines replaced with less highly-tuned units; FCFs were flown to confirm each aircraft's readiness for its transpacific flights.

During an FCF on 2 June 1968, Frank Murray got airborne and headed south of Okinawa well away from unfriendly land-based radars. The well-worn test and training route was tear-drop shaped, pointing toward the Philippines, where a long, shallow, 190° turn was initiated back towards Kadena. This high and fast cruise leg continued over the base and was followed by a tighter let-down tear-drop pattern, which brought the aircraft in towards final approach.

After taking fuel from a tanker, Frank flew the full route, but recalled that the right engine would not go into bypass until it reached Mach 3, as opposed to the normal speed of Mach 2.6. The flight continued without further incident until Article 129 passed over Kadena, where Frank began his deceleration and decent. At that point, he discovered the right engine would not come out of bypass. As deceleration continued, the inevitable happened. Since the bypass system continued to deliver most of the air to the afterburner section and very little to the combustion section, the engine flamed out. Once 129 was subsonic, Frank restarted the engine and recovered into Kadena without further incident. It was obvious that the right engine would have to be changed to solve the problem.



▲ This is a copy of the chart used by Frank Murray to position the last remaining A-12 from Area 51 to Lockheed's Palmdale facility following programme shutdown. This final mission was code named Scope Barn. (Roadrunners Internationale)

On 4 June, Jack Weeks left Kadena in 129, with the intention of finishing the FCF; he completed a 34,000lb fuel on-load from the tanker, accelerated and climbed away. That was the last anyone saw of pilot or aircraft. Forty-two minutes into the flight, the Birdwatcher at Kadena received a signal from channel 54, indicating that starboard engine EGT was in excess of 860°. Twenty-two seconds later, Birdwatcher repeated the signal, while a transmission from channel 7 indicated that fuel flow to the same engine was less than 7,500lb/hour. Eight seconds on and a third and final Birdwatcher transmission was received. It repeated the earlier information from channels 54 and 7, but this time included a signal from channel 3, ominously indicating that the aircraft was at or below 68,500ft.

From this limited evidence, it is reasonable to conclude that a malfunction involving an over-temperature and low fuel flow to the right engine contributed to what appears to have been a catastrophic failure and subsequent aircraft break-up. Not a trace of wreckage was found and it is particularly ironic that such a highly competent and professional pilot should have been lost on one of the very last flights of the Oxcart programme.

The two remaining A-12s on Okinawa (Articles 127 and 131) were to be ferried back to Area 51 before being positioned to Palmdale. On 7 June 1968, Frank Murray boarded 131 for the flight back to the US. He topped off his tanks near Iwo Jima and then flew a 'hot leg' to Wake Island, where he decelerated for another refuelling. Before 'plugging in', he noticed a high rate of fuel flow on the right engine. Through the small rear-view periscope, he saw that the right engine was leaving a trail of unburnt of fuel behind the aircraft. He told the tanker crew he had a fuel leak and that he would have to dump much of the remaining JP-7 before landing at Wake Island.

▶ Article 129 (60-6932) completed five Black Shield missions. It was lost with its pilot Jack Weeks in an accident on 5 June 1968. (Lockheed Martin)

▲ Ken Collins finally made it to Hawaii after multiple engineering issues delayed his launch from Wake Island. He was attempting to ferry an A-12 back to Area 51 in 1968, following termination of the Oxcart programme. (Via Ken Collins)

◀ Eight A-12s and the remaining M-21 were placed in long-term storage inside a hangar at Palmdale. Note the false serial number, 60-6937, applied in red to Article 131 during Black Shield. (Lockheed Martin)

◀ When Oxcart was finally declassified, A-12 Article 128 (60-6931) was flown by two C-5s to the Minnesota Air National Guard Museum, before being moved to its current location – CIA headquarters at Langley, Virginia. (Tony Landis)

After the recovery team arrived, the afterburner (A/B) fuel line was replaced and the aircraft flight-tested. Next, Ken Collins flew 131 at subsonic speed into Hawaii's Hickam AFB for a full service prior to the final leg home. It was found that the airframe-mounted gearbox was out of alignment and vibrating so badly that it caused fuel lines to break. From Hickam, it took Frank Murray three more attempts before he was able to coax the reluctant A-12 back to the 'Ranch'.

▲ The CIA operational unit that flew Oxcart was known as the 1129th Special Activities Squadron, 'The Roadrunners'. (Via Frank Murray)

Meanwhile, Denny Sullivan had flown the last Oxcart aircraft back from Kadena to Nevada on 9 June, in just five hours 29 minutes.

After it was all over, Maj Bill Wuest, Area 51's poetic weather officer named the 'Bard of Beatty' after a small town just outside the area, penned the following rhyming couplets in honour of those two 'record-breaking' return trips.

Congratulations from the Bard of Beatty – 19 June 1968

When Denny rushed across the Pond in Five-plus-Twenty-Nine,
All hopes had sunk for Ken and Frank to break the record time.
But nothing daunted, that slow pair conspired to save the day.
With greatest skill and cunning broke a record anyway.
Eleven days it took them both to make that ocean trip.
The slowest 'Record', high-speed flight was now within their grip!
That Record time they'll surely keep until the final day.
For Beale's crews will never want to take their TIME away!

The final A-12 flight took place on 21 June 1968, when the last Cygnus, Article 131, was ferried from the 'Ranch' to Palmdale by Frank Murray. At the Lockheed plant, company maintenance technicians drained all its fuel and hydraulic lines, while employee Mel Rushing skilfully 'interwove' all nine remaining Oxcart aircraft into a tightly-regimented, sardine-like parking array in a corner of one of the large hangars, where they remained for more than 20 years, before being dispersed to museums.

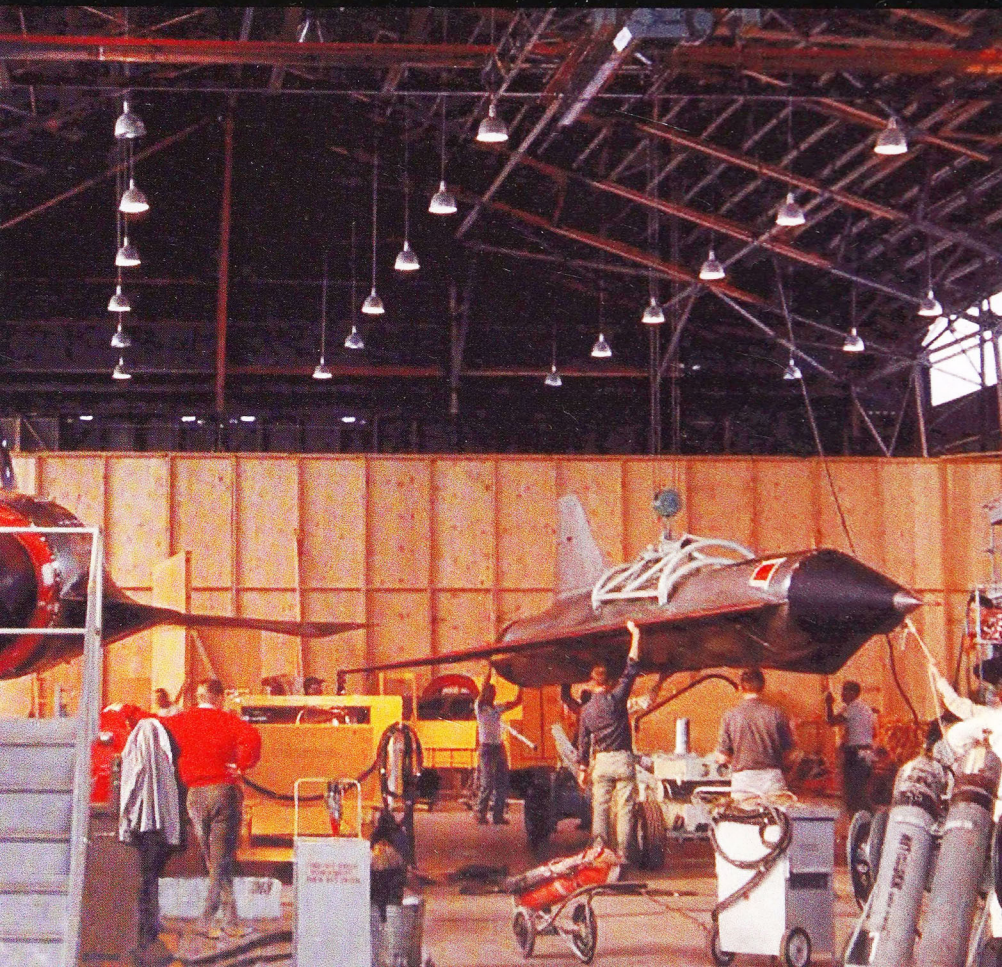
On 26 June 1968, Deputy Director of the CIA Vice Admiral Rufus Taylor presided over a ceremony at Area 51 where he presented the CIA Intelligence Star for Valor to Ken Collins, Jack Layton, Frank Murray, Denny Sullivan and Mele Vojvodich for their participation in *Black Shield*; the posthumous award to Jack Weeks was accepted by his widow. The Legion of Merit was presented to Col Slip Slater and his deputy, Col Amundson. In addition, the Air Force Outstanding Unit Award was presented to members of the Oxcart Detachment, the 1129th Special Activities Squadron, also known as 'The Road Runners', after the speedy ground cuckoo indigenous to Mexico and the southwestern United States.

◀ The coveted CIA Intelligence Star for Valor. (via Dennis Sullivan)

The long-standing debate concerning whether Oxcart or Senior Crown should carry forward the strategic reconnaissance baton had, after three years, been resolved, and the former was vanquished. In early March 1968, SR-71s began arriving at Kadena to take over what had been the *Black Shield* commitment.

▼ The five (suited) A-12 pilots to have flown Black Shield missions are awarded the CIA Star for Valor. Left to right (just in shot): Mele Vojvodich, Dennis Sullivan, (Admiral Rufus Taylor, Deputy Director CIA), Jack Layton, Ken Collins and Frank Murray. (Roadrunner Internationale)

CHAPTER 6

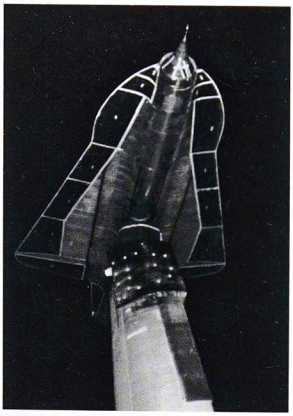


TAGBOARD AND SENIOR BOWL

In the political fall-out from the U-2/Frank Powers shootdown, a meeting between Kelly Johnson and Dr Eugene Fubini, of the Office of Defense and Engineering, took place at the Pentagon early in 1962. Kelly was asked if it would be possible to develop a small-scale version of the A-12 that could be droned, carry a reasonable reconnaissance payload and possess similar performance characteristics to that anticipated for the Oxcart. Fubini believed that were such a parallel development possible, it would afford the president a choice between a manned or unmanned platform from which to conduct 'reconnaissance of critical denied areas'.

Perhaps not surprisingly, Kelly responded enthusiastically, believing that such a machine was entirely feasible and that its development timescale would be compatible with that of the full-scale platform; he further suggested that the drone could be launched from a modified Oxcart vehicle. As a consequence, the Skunk Works were authorised to perform a six-month drone configuration and feasibility study.

◀ D-21 drone 501 about to be craned slowly onto its mounting pylon on the back of M-21 134. There was a mere 6in. of clearance between the drone's wingtips and the M-21's twin tails. (Lockheed Martin via Tony Landis)



▲ The characteristic double-delta planform of the D-21 is evident during RCS tests on the Area 51 RatScat range. (Lockheed Martin via Tony Landis)

In a memo to Secretary of Defense McNamara, dated 26 September 1962, Dr Joseph Charyk, Director of the NRO, noted that the drone programme, now known as Project Tagboard, '...appears to offer an alternative means to the A-12 and satellite systems for the purpose of overflight photography, but it seems to me that the drone would provide no better overflight capability than the A-12 will provide and, from my assessment, the political considerations in sending a drone on this type of mission are not significantly different from the political considerations in manned overflight.' He did, however, recognize that a scaled-down version of the A-12 would result in a vehicle with an equally reduced RCS, making the enemy's task of tracking it during clandestine overflight operations more difficult.

During a meeting between McNamara and DCI Allen Dulles on 5 October, it was agreed to proceed with the initial stages of Tagboard. However, in view of the system's technical uncertainties, it was further agreed that the programme would be carefully reviewed after the initial study and feasibility phase had been completed. A subsequent meeting between Dr Charyk and Dr Herbert Scoville, CIA Deputy Director (Research), determined that management responsibility for the project should, as in the case of Oxcart, sit with the CIA, and that the DoD should assign an individual to the Agency who was both 'knowledgeable and enthusiastic' for the programme.

On 9 October 1962, Kelly provided a written proposal of the feasibility study to the Assistant Director OSA, which included a completion date for the work of 2 January 1963. In a memo to Herb Scoville dated 17 October 1962, Dr Charyk stated: 'NRO management responsibility for this development is assigned to the Director, Program B (AD/OSD)' and that he, Dr Charyk, 'was prepared to assign Lt Col Henry Howard from the NRO Staff to the Director, Program B, for this important task.' (In a classified memo to the DCI from Herb Scoville dated 12 June 1963, the latter noted that 'nothing further

▲ Bill Park flew all the mated M-21/D-21 flights, the first of which occurred during the late afternoon of 22 December 1964. (Lockheed Martin)

was heard from the NRO Staff on Colonel Howard's nomination to this Agency' – an indication of the friction that had developed between the NRO and the CIA at this time). Nine days later, Scoville responded to Charyk's memo and confirmed that 'Colonel Jack C. Ledford, USAF, Director, Program B, has assumed managerial responsibility for the AQ-12 drone project.'

On 5 November 1962 Kelly wrote in his diary:

> The drone is developing without much discussion between Headquarters and ourselves. I think I know what they want, but no one has spelled it out. We will try to get 6in. ground resolution photography, a range of 3,000nm, and a payload of 425lb for the camera. We will attempt to save the expensive elements of the aircraft by parachute recovery of the nose.

While Lockheed continued with the feasibility study, the OSA was busy soliciting camera proposals for the AQ-12 drone from likely manufacturers. On 3 December 1962, firm proposals were received from Eastman Kodak, Perkin-Elmer, ITEK Corporation and the Hycon Manufacturing Company (Hycon was Kelly's preferred option and later won the contract to build one prototype and nine production cameras).

Both Charyk's and Scoville's respective departments closely analysed Kelly's feasibility studies and recommended that the development of Tagboard should proceed, a decision further endorsed by both the SecDef and DCI during a subsequent meeting. Consequently, on 28 February 1963 Lockheed was given the go-ahead for the procurement of 20 drones. In addition, modifications were to be made to two A-12s into drone launch configuration (the A-12 conversion programme was referred to as Wedlock in a later classified document written by John Parangosky, who at the time of writing was the CIA's Deputy Director of Special Activities). These proposals were later confirmed in an official letter from the CIA dated 20 March 1963.

Meanwhile, there was ill feeling between the CIA's Herb Scoville and the NRO's newly appointed director, Dr Brockway McMillan, as the latter attempted to wrestle control of Tagboard away from the CIA and over to the USAF. On 4 June 1963, McMillan signed a memo to Scoville and the Director of Program D assigning responsibility for conducting Project Tagboard to Colonel Leo Geary, USAF, Director of Program D (a post later held by Col Saunders).

Earlier that year, Bob Murphy received a telephone call from his boss Robert Pouc, who informed him that he intended to promote 'Murph' to superintendent. Lockheed was

◀ Tagboard is made ready for the first mated flight. Note the camera mounted on the right cockpit rail to monitor flight instrumentation and the F-104A-20-LO chase aircraft 56-0801 in the background. (Lockheed Martin)

▶ The D-21 LCO could top up the drone's fuel tanks by transferring fuel from the M-21. (Lockheed Martin)

carrying out modifications to Air Force U-2s that would enable them to use the more powerful J75 engine, and 'Murph' was to head up the programme. Delighted by the news, he soon received another phone call, this time from Kelly's secretary requesting his presence. Kelly said, 'Murph, I'm going to promote you to superintendent,' to which Bob replied, 'Yes, I know.' 'How do you know? I've only just told you.' It was his second promotion that day!

But what Kelly had in mind was something radically different from Murph's earlier promotion. The ADP boss showed his newest superintendent some sketches of an altogether strange-looking beast designated the D-21. Johnson instructed Murph to 'find a building for housing the necessary engineering and build them.'

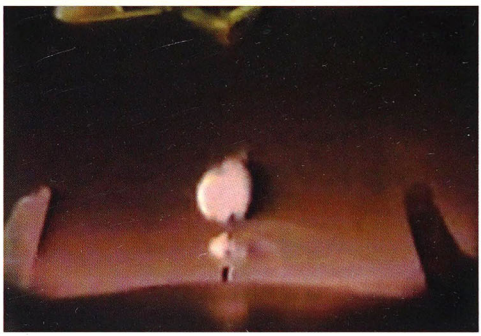
Initially the Lockheed programme manager for Tagboard was Rus Daniell, but when he became involved in the development of the RS-12, responsibility for the D-21 became the purview of Art Bradley. The launch platforms were A-12 Article numbers 134 and 135, 60-6940 and 60-6941, respectively. To reduce the possibility of Skunk Works personnel confusing the A-12 with the drone-carrying variant in documentation or security issues, it was re-designated M-21 (the M standing for 'Mother'), and the two digits were also intentionally reversed. With construction under way in Building 309/310 at Burbank, a fit check – using M-21 134 and D-21 501– was completed successfully on 19 June 1964 inside the manufacturing plant. On 12 August 1964, the M-21 prototype, Article 134, was trucked to Area 51 to undergo initial post-modification flight testing.

Built primarily from titanium, the D-21 had a frontal area RCS of just $0.2m^2$ from a 15° depression angle; it had a range of 1,250nm, cruised at Mach 3.3, possessed an end-of-cruise altitude capability of 90,000ft and was powered by a single Marquardt XRJ-43-MA20S-4 ramjet. The drone burned PF-1 fuel, the same as that used to power the M-21's twin J58 engines.

The drone was carried on a pylon and launched from the M-21 by a Launch Control Operator (LCO) located in what was the A-12's Q-bay; the drone then flew its sortie completely independently. The mission was accomplished by the D-21's pre-programmed INS, into which had been loaded the desired track, flight profile, camera on and off points, and bank angles, allowing it to satisfactorily execute the perfect photo-recce sortie.

The CIA's COMIREX controlled the classification of film for Tagboard, Oxcart and other black world reconnaissance projects, and for this programme each mission would be classified Top Secret, the handling caveat being 'NO FOREIGN DISSEMINATION', and to further protect the platform's security code word (Tagboard), each frame was allocated the non-aligned code of 'Chess'.

Having completed its camera run, the drone's INS sent signals to the autopilot system to descend the vehicle to a pre-programmed 'feet wet' film collection point. At the appropriate position and altitude, a palletized panel containing the INS and camera unit was ejected and allowed to parachute towards the ground. As the drone continued its descent, it would be blown apart by a barometrically activated explosive charge. The drone's INS and the HR-335 camera containing its valuable film would then be retrieved by a Lockheed JC-130B Hercules equipped with a Mid-Air Retrieval System (MARS), then flown to a base where the film would be extracted and sent for processing and analysis.



▲ Two frame grabs from the M-21's high-speed cameras, mounted in pods between the M-21's fuselage and engine nacelles, catch the moment of drone launch at Mach 3.12. (CIA via Toni Hiley)

During the early development stages of the D-21, tests were conducted at Area 51 using a JC-130 to validate recovery techniques of the reconnaissance pallet. The pallets were airdropped from a B-66 flying at maximum altitude, and the C-130 took up a racetrack holding pattern in readiness to catch them. It was deemed necessary to document these events on film, so a photo chase platform capable of flying in formation with the JC-130 at about 24,000ft had to be identified.

Neither the Area's F-101s nor the T-33s used as currency trainers and 'hacks' were up to the task, and since the C-130 would be flying with its flaps down, the U-3B was also unsuitable. As instructor pilot (IP) for the Cessna 210, Frank Murray volunteered to attempt to take it up to 24,000ft to see if it was capable of performing the job, as he now explains.

> I loaded our trusty Lockheed movie photographer on board and took off to see… bearing in mind that the 210 had the most rudimentary oxygen system, just a plastic mask of sorts and a small oxygen cylinder. The Cessna's handbook indicated that flight at 24,000ft was possible and I managed to get it up to that altitude and about 125kt, thanks to the turbocharger. We returned to base with the good news and were scheduled on the next MARS mission.
>
> I took off first, rendezvoused with the C-130 and the game was on. The 'Herky-bird' acquired the radar beacon on the pallet when the 'chute was deployed on

descent; it flew a race track pattern over the intended drop zone, and I followed a bit higher, so that I could manoeuvre into position and dive off a bit of altitude if I needed to be in position for the pallet pick-up.

It was planned that the MARS C-130 would make repeated passes at the descending pallet's 'chute until he either caught it or had to quit trying due to getting too low. If I remember correctly, the first attempt did not result in a catch, so the pallet let down all the way to the lakebed, north of the Area, in the vicinity of the A-12 refueling track in the SOA. So we flew home without much except for some pictures of him trying to capture the thing. Interesting flying really, but then I had all kinds of interesting flying in my five years at the Area and elsewhere.

Another MARS sortie was scheduled shortly afterwards and off we went again. The tactics of the first mission had worked, so nothing was changed in either my plan or theirs. After a while the C-130 reported that he had contact with the beacon, so he adjusted his pattern to suit the catch. As usual, I'm behind and a little higher than him. Soon we both see the pallet and shout, and he heads in. I'm slightly out of position and behind him, so I let down towards him in a turn calculated to cut him off and be in a position for filming. But at about this time I fly through his turbulent wake path and the poor little 210 gets tossed around like a rag doll. At one point I saw the big 24v battery that powered the movie camera right next to my head, it had been sitting on the floor at the back of the 210; luckily it came to rest on the seat in the back and we just barely got our pictures – the MARS was also successful this time.

The maiden flight of Tagboard took place at Area 51 on 22 December 1964. Take-off time slipped because of delays brought about by the late arrival of senior Lockheed executives, who had attended the maiden flight of the SR-71 down at Palmdale earlier that day. Despite its early, lower-powered J58 engines, Park was still able to take Tagboard supersonic.

Keith Beswick was a Lockheed flight test engineer assigned to the Oxcart programme at Area 51. He initially worked with other engineers on Article 121 before becoming lead engineer on 123, 124 (the pilot trainer), and 129 (the electronic inlet control test-bed aircraft). He then transferred over as lead engineer to Articles 134 and 135 on Project Tagboard, flew several flight test sorties as launch control operator (LCO) with Lockheed test pilot Bill Park, and recalls:

With the D-21 in place, it generated considerable drag, which created difficulties for the M-21, particularly during the transonic phase of flight. To begin with it resulted in an exponential fuel burn. So once airborne from Area 51, the first order of business for the 'MD-21' (and incidentally most of the A-12s used the same procedure to reduce take-off weight) was to rendezvous with the KC-135Q tanker

▼ The second M-21, Article 135 was lost on 30 July 1966. (Lockheed Martin)

and top off the tanks.

Once topped off, according to Ben Rich and Dick Fuller, we should accelerate to 250kt and then hold that speed and we'd be able to accelerate through Mach 1 'in no time at all'. But in reality it wasn't as straightforward as that. We attempted this a few times and we'd get out to 0.97 Mach, but just couldn't accelerate any further, meanwhile our fuel burn went through the roof! Back in Burbank at the Skunk Works, Bob Biffle, one of our flight test analysts, had been running some numbers and came up with a possible solution to our problem.

▲ A frame grab from the high-speed camera carried by Keith Beswick in Article 134 captures the disintegration of Article 135 following its collision with drone 504. (CIA via Toni Hiley)

He suggested after accelerating to 0.90 Mach, we start a 0.9 Mach climb and hold it until our rate of climb had decayed to 200 or 300ft/min and then push over into a fairly steep dive, so we gave it a try. Once we reached about 42,000ft the climb rate had washed away. Bill [Park] eased the nose down into a descent of 30–40°, the Mach built up and he pulled out at about 29,00ft and 1.17 Mach, and we were able to continue the climb and acceleration with a much reduced fuel burn. A few flights later, we found that once we were above Mach 1.2, we could start the D-21's ramjet engine and this would augment available thrust.

By May 1965, Kelly noted in his log, 'We are ready to light the engine of the drone, but we must get a new course to run as we cannot accelerate sufficiently in a turn. We are being restricted by a lack of suitable test areas.' On 21 October, Kelly noted, 'We have had great difficulties getting Tagboard out to speed and range. We tried to run to Point Mugu for launch practice, but couldn't make the range. Transonic acceleration is very poor, particularly with high air temperatures. As of this day, we are putting in 34,000lb thrust engines. Have had to convert from the Hamilton Standard inlet control to our own, and are having trouble blowing the nose cone [the ceramic nose cone cover over the D-21's inlet] and keeping parts out of the inlet.'

Keith Beswick remembers:

As the programme progressed it became time to practise D-21 launch procedures. For this we'd refuel the M-21 and D-21 from a KC-135Q in an AR track about 50nm north of the test site. With full tanks we then routed northeast over to Mountain Home AFB, Idaho, and then turned and continued towards Dalhart, Texas, where we would rendezvous with another tanker, top off and then head directly towards Point Mugu NAS, California. During this leg, about 150 miles east of Point Mugu we'd reach Mach 3.2 and 80,000ft.

The procedure then called for Bill to lower the nose to get 0.9G, which should enhance drone separation. On one of these practice manoeuvres, as we nosed over, both inlets unstarted. Bill conducted a quick instrument panel scan, but we knew it was pointless trying to get the engines started until we got down into more dense air, below 50,000ft. Passing through 50,000ft Bill attempted the restart … no luck. The aircraft remained very stable and he tried another restart at 40,000ft, still nothing. He attempted yet another at 35,000ft, and still the engines refused to start. By this time we were about 100 miles west of Point Mugu over the ocean. So Bill said to me, 'Well, what do you think we should do.' So I said, 'Well I don't know, it's your airplane that's in trouble.' Bill replied, 'Yeah, but you're in my

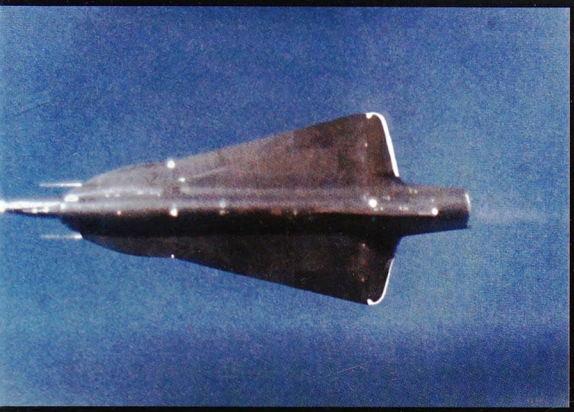
▶ Project Senior Bowl used two B-52H Stratofortresses to launch D-21Bs equipped with a solid rocket booster, constructed by the Lockheed Propulsion Company in Redlands, to enable it to reach the required ramjet speed. (Lockheed Martin via Tony Landis)

airplane *too* and if we don't get this thing relit by 18,000ft I'll be leaving, so it will be your airplane.' I should say that our conversation was very calm, and the guys commented on this fact when they played the cockpit voice recorder back at base.

The fact is that I'd flown with Bill on many occasions and I still think he was the most professional, unflappable pilot I've ever flown with. So anyway, we're now approaching 25,000ft and Bill said, 'Any ideas?' I responded, 'Well, I guess there's always the checklist.' So I began reading through it. 'Inlet spikes forward?' 'Yeah, the spikes are forward.' 'Forward bypass doors open?' 'Yeah, they're open.' 'Aft bypass doors closed?' '…' Then there was a click, click (which was the aft bypass doors closing) and almost immediately both engines restarted! The problem was that we'd left the aft bypass doors open (which is the normal Mach 3.2 configuration) after the inlets unstarted. We recovered without further incident and returned to the test site. During the post-flight debrief, one of the Air Force sergeants asked, 'with the D-21 on your back, and both of your engines out, how did the airplane glide?' Bill replied, 'About like a manhole cover!' Flying with Bill Park was always a privilege and a pleasure.

Bill Park piloted all the M-21/D-21 mated sorties. The monumental problems concerning platform and systems integration that Tagboard had to overcome cannot be overstated, but by 1966 the programme had progressed to the point where vehicle separation was to be performed.

The mission profile during this critical stage called for Bill to fly the aircraft at Mach 3.12 and commence a slight pull up at 72,000ft, then push over to maintain a steady 0.9G on the highly sensitive G-meter fitted in the M-21. With controllability checks on the



▲ A D-21B in free fall from its B-52 launch pylon before the rocket booster is fired. (Lockheed Martin via Tony Landis)

▶ With its SRB ignited, the drone begins its rapid climb and acceleration away from the B-52 launch platform. (Lockheed Martin via Tony Landis)

D-21 completed and its ramjet 'burning', Keith Beswick initiated vehicle separation.

Park and Beswick achieved the first successful vehicle separation on 5 March 1966, but drone number 503 was lost just 120 miles from the launch point. A second launch was completed by Park and LCO Ray Torrick on 27 April, with drone 506 adhering to its pre-programmed course to within half a mile during a flight of 1,200nm. It reached an altitude of 90,000ft and Mach 3.3 before finally falling out of the sky and into the Pacific Ocean after a hydraulic pump burned out, the whole flight having been followed from the ground by Kelly, who had flown into Point Mugu for the event.

A second batch of D-21s was ordered on 29 April 1966, and the following month Kelly made a formal proposal to SAC to launch the new drone from Boeing B-52Hs, on the basis of greater safety, lower cost, and greater deployment range. On 16 June, drone 502 successfully completed a third launch from the M-21, as Kelly noted in his diary. 'It flew about 1,600nm, making eight programmed turns, to stay within sight of the picket ship. It did everything but eject the package, due to some electronic failure.'

The fourth launch was to take place on 30 July 1966. Keith Beswick takes up the story.

> We briefed the previous day and reviewed details again the morning of the flights. Flight crew assignments were: Bill Park, pilot, and Ray Torrick, the launch control engineer, in Article 135 with drone number 504. Art Peterson would pilot for Article 134, and I'd be in the back seat as engineering observer. We then reviewed the aircraft maintenance status: fuel loads (this was the first time the D-21 would be launched with a full fuel load), tanker status and rendezvous plans, and our take-off plan – Article 134 and an F-101 chase would take off first and circle back to pick up 135 at the start of its take-off roll. The tanker refuelling order was 134

to hit the tankers first, so that 135 could begin its acceleration immediately afterwards. We then went through the aircraft's instrumentation status for the test aircraft and telemetry ground stations, weather forecasts both en route and at the test site, and the en route communications.

We got suited up two hours prior to take-off and were airborne on schedule at 0700. The route was the same as on our practice launch flights. The flight from Dalhart was pretty routine, both aircraft reaching 3.2 Mach and 80,000ft about 200 miles east of Point Mugu. Article 134 was about 500ft off 135's right wing. I was operating a high-speed camera in the back seat of 134, watching the activity through the small viewfinder on the camera and trying to keep my helmet and the camera pointed in the same direction.

When launch occurred, the D-21 appeared to rise up then rolled to the right, crashing into the outboard trailing edge of 135's right wing. The airplane's nose pitched up to about 45° and then broke off and it was gone. Oddly enough, the aft fuselage seemed be flying along, trailing fuel, but quite stable. The instant we realized what was happening, Art Peterson yelled over the radio, 'Mark it, mark it, mark it,' so the Point Mugu radar operators would record the exact location to help subsequent search and rescue operations.

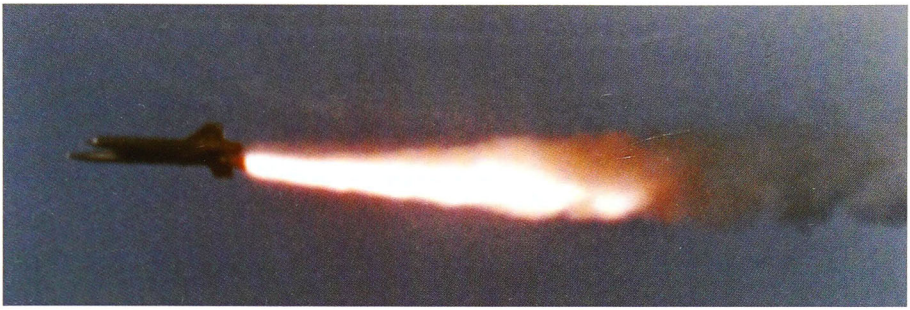
Inside the remains of the tumbling forward forebody, with their life-support pressure suits inflated, Park determined that despite their altitude and speed the chances of survival were better outside. Both he and Torick therefore ejected and made a 'feet-wet' landing in the ocean.

Keith Beswick continues: 'Our flight back to the test area went without incident, our mood sombre as we wondered about the fate of Bill and Ray and what had gone so badly wrong. An hour or so after we landed we were told that Bill and Ray were ok, but shortly afterwards we got further news that Ray had drowned.'

The facts as to what may have caused the collision remain largely conjecture, but the consensus is that the D-21 rose up slower through the M-21's shock waves (possibly because of its full fuel load) than on earlier test flights. This caused the D-21's inlet to unstart, which in turn would have disturbed the drone's hydraulic, electrical and flight control systems, which resulted in a loss of control at a critical stage of the launch process.

Following a review conducted by the NRO after the fatal Tagboard collision and completed in September, the Skunk Works was advised that it had been decided to reorientate the programme. The B-52 had already proved itself as an efficient, safe launch platform with NASA for dozens of different craft from lifting bodies to the X-15; therefore it had been decided that SAC would make available two B-52Hs from which to launch a redesigned variant of the D-21 (as Kelly had proposed back in May). Although this reorientated programme used exactly the same Marquardt XRJ-43-MA20S-4 ramjet, the D-21B's inlet was modified and fitted with a less sensitive pressure sensor. The major external change was the fitting of a large, jettisonable solid propellant rocket booster located under the drone's fuselage. When released from the B-52, the rocket accelerated the drone to a speed and altitude that enabled the ramjet to function. However, after the reorientation programme was under way, Kelly Johnson ascertained that the proposed solid rocket booster (SRB) required more thrust and therefore needed to be redesigned and increased in size, which inevitably led to delays.

The Avanti A-92 booster had a length of 44ft 3in., a case diameter of fractionally over 2ft 6in., a weight of 13,286lb, an average thrust of 27,300lb and a burn time of 87 seconds. Once the drone was released, at about 38,000ft, the booster was ignited,



▲ The Avanti A-92 rocket booster had a burn time of 87 seconds and produced 27,300lb of thrust. (Lockheed Martin via Tony Landis)

accelerating the drone out to Mach 3.2, at which point the functioning ramjet would take over and the exhausted rocket was jettisoned. Thermodynamic stresses on the drone during the launch sequence were severe, as the platform was blasted rapidly from an ambient temperature state of circa -60°C to cruise speed and airframe temperatures way above 220°C in under a minute and a half. To protect the drone from the rocket's hot exhaust gases, a flame shield-type nozzle was added to the rear of the rocket.

The Air Force delivered the first B-52H (61-0021) for programme modification to the Lockheed Palmdale facility at Air Force Plant 42, Site 2, on 12 December 1966. A few months later it was joined by 60-0036. Designed to carry two D-21Bs on wing pylons located between the fuselage and the inboard engine pylons, the two B-52s had the ECM operator and tail gunner's panels situated in their upper-rear crew stations removed. In their place were installed identical launch panels for the D-21Bs on the right and left wing pylons.

The SAC unit tasked to operate the new programme, now code named Senior Bowl, was initially designated 'A' Flight, but later became the 4200th Support Squadron, based at Beale AFB.

Between 6 November 1967 and 10 July 1970, 11 Senior Bowl flight test sorties were flown from Area 51, all using the Pacific Missile Range (PMR) located off the coast of California. Critical to the success of any operational mission would be the recovery of the drone's hatch that contained the INS, the Hycon HR-335 camera and its Kodak film. During five of the test sorties the hatch was successfully recovered on four occasions in mid-air by a JC-130, although on one sortie the services of the US Navy were called upon and the pallet was recovered from the ocean.

Once the system was declared ready for operations, the 4200th Support Squadron moved back to Beale AFB. On 9 November 1969 the first operational mission was attempted with D-21B number 517. The collection area was to be southern China. To maintain tight security, the B-52, hauling its unique payload, departed Beale at night and lumbered westwards to Andersen AFB on the Pacific island of Guam. Just before dawn the next day the flight resumed, the 'bomber' departing Guam and heading for the launch point. Upon vehicle separation, the B-52 made its way back to Guam while the drone climbed and accelerated on course to China, ready to begin a daytime reconnaissance run.

During the sortie, both the launch and boost phase were successful and the drone attained its programmed altitude of 84,000ft and a cruise speed of Mach 3.27. The NSA reported that with the drone's telemetry turned off 50 miles off the island of Hainan and 80 miles from the Chinese mainland, well within the range of coastal air defence radars, no SIGINT activity could be correlated with the mission.

However, a phenomenon known as integration error in the drone's INS prevented it from flying the pre-programmed route. It is believed that 517 continued on its initial track, which carried it far into the wilderness of the former Soviet Union before its self-destruct charge was triggered automatically upon descent after the craft's fuel supply had been exhausted.

On 20 February 1970, drone 521 completed a flight test sortie into the PMR. Fail-safe modifications to the INS software were validated, the hatch was air-recovered by a JC-130 and once again it was time to attempt another operational mission.

The second operational mission was undertaken by D-21B airframe number 523 on 16 December 1970. This drone completed its 2,648nm sortie only to lose its payload at sea following a partial parachute failure.

During operational mission number three, flown by drone 526 on 4 March 1971, the 2,935nm flight was completed flawlessly. The recce pallet was ejected and its 'chute fully deployed, but unfortunately the JC-130B missed the aerial recovery and the valuable payload splashed into the Pacific. Procedures for such an eventuality had been prebriefed, however, and with a US Navy recovery ship on station all was apparently not lost.

The vessel failed to recover the pallet on its first pass, so a Navy SEAL team went over the side to render assistance. But the pallet was still attached to the parachute cables and these were reinforced with stainless steel wire. The SEALs couldn't cut through them; even worse, the drone's parachute now acted as a sea anchor, so that when the vessel made a second attempt at recovery by positioning upwind and drifting towards the floating pallet, it drifted over the top, keel-hauling it and consigning it forever to Davy Jones's Locker.

The fourth and final mission was flown just 16 days later by number 527 on 20 March 1971. It was lost on the last leg of the route over the People's Republic of China in Yunnan province, and the wreckage was recovered by local authorities. In 2010, it was moved from China Aviation Museum's junkyard and put on display.

Intelligence sources have stated that Chinese radar controllers managed to track the D-21 over their territory at least once, incorrectly identifying

▲ Drone 527 was launched against the People's Republic of China on 20 March 1971. It was Senior Bowl's fourth and final operational mission. The drone was either shot down or crashed following a mechanical failure and is seen here after being found relatively intact. (Via Lin Xu)

▶ Drone 527 being recovered through 'people power'. (Via Lin Xu)

it as 'The Big One', their adopted term for the SR-71. The incident resulted in Peking protesting to Washington that SR-71s were violating its sovereign airspace and this, and similar incidents formed the basis of rumours that have persisted ever since. Indeed, President Richard Nixon perpetuated such rumors when, during the course of his state visit to China in February 1972, he promised that 'all SR-71' overflights of China would be halted.

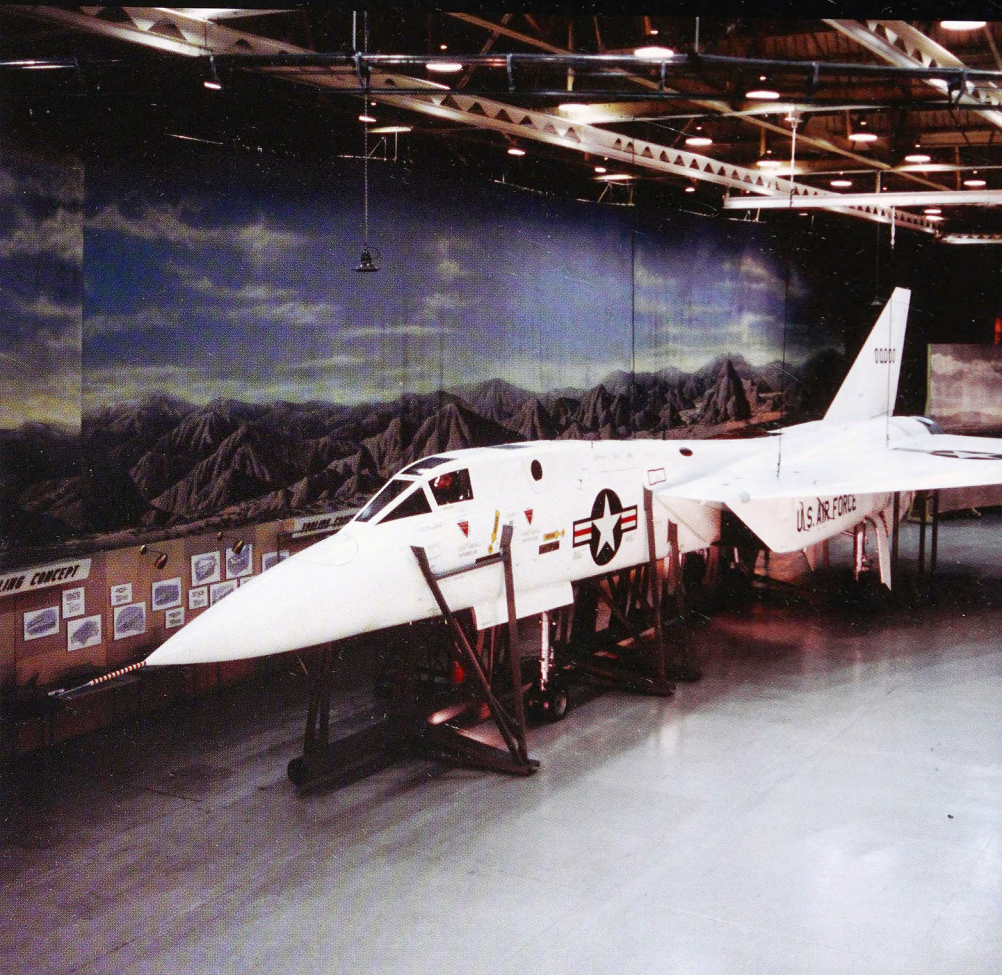
On 23 July 1971, the Senior Bowl programme was cancelled, due to its poor success record. At a cost of $5.5 million (1970 dollars) per mission, it had failed to produce a single image of denied territory, despite the best efforts of an outstanding team. In addition, a new generation of photo-reconnaissance satellites had been developed, the use of which was more politically acceptable over sovereign nations than manned aircraft or drones.

In total, four D-21s were launched during Tagboard and 16 D-21Bs during Senior Bowl. Thirty-eight were built and those that remained were initially stored at Norton AFB, before being moved to the 309th Aerospace Maintenance and Regeneration Group (AMARG) at Davis-Monthan AFB, Arizona, which is where they were first spotted by 'outsiders' in 1976. Since programme declassification, many have been placed on loan as museum exhibits.

In a final interesting twist, many years after the cancellation of Senior Bowl and after Ben Rich had retired as president of Lockheed's Skunk Works, he recalled how during a visit to Moscow he was presented by the KGB with what they believed were the remains of a 'stealth fighter' that had crashed in their territory. Checks on arrival back home indicated that in fact the 'trophy' had come from D-21B 517.

▼ Having undergone a thorough evaluation by officials and engineers, 527 spent many years languishing in a museum junk yard before being rediscovered and put on permanent display. (Via Lin Xu)

CHAPTER 7



KEDLOCK

During the late 1950s a specification was drawn up to provide a fire control and missile system for the North American F-108 Rapier interceptor. Improved Manned Interceptor (IMI), the F-108 was to be Mach 3.0 capable and its AN/SG-18 pulse-Doppler radar system, developed in parallel with the GAR-9 Falcon missile by Hughes, would have a look-down/shootdown capability for head-on attacks. Furthermore, the system considerably advanced the maximum range of contemporary airborne intercept monopulse systems then in use, from 40 miles to 120 miles.

As development of aircraft and avionics progressed, a Convair B-58 (55-665) was bailed to Hughes to act as a systems testbed. Delivered to the Hughes main plant at Culver City, California, it was on the ground in excess of a year while re-configuring work prepared it for the missile and ASG-18 fire control system (FCS) flight test programme. While this was being undertaken, Hughes engineers were using high-speed techniques and a 9ft-deep pit filled with foam to analyse separation and pitch characteristics of the 818lb missile. In the air missile/vehicle separation was provided by two 'thrusters', one located at each end of the missile. On firing, these charges unlocked the missile from its rail and then forced the missile down, clear of the aircraft. At a finite time, its rocket motor ignited and the GAR-9 sped away.

◀ The North American F-108 Rapier was to be equipped with the Hughes AN/ASG-18 fire-control system, but it never progressed beyond the full-scale mock-up stage. (National Archives via Tony Landis)

MR MISSILE

Jim Eastham, a native of El Dorado, Kansas, began his aviation career in 1942. Having graduated as a primary flight instructor, he was called to active duty two years later. Completing his US Army Air Force pilot training in class 45-1; he graduated and received his commission at Luke Field, Arizona. One of the original Berlin airlift pilots, Jim flew a number of aircraft types, including F-84s, with the 31st Strategic Fighter Wing.

Released from active duty, he gained a mechanical engineering degree from Georgia Tech in 1955 and became a production test pilot with the McDonnell Aircraft Corporation on the F2H Banshee and F3H Demon. Jim's next move ultimately earned him the nickname 'Mr Missile' when, in October 1956, he joined the experimental flight test department of the Hughes Aircraft Company and was assigned as project pilot on the Falcon missile programme at White Sands Missile Test Range, New Mexico. Over the next four years, Jim flew almost 800 test missions in the F-102 and F-106, firing in excess of 350 missiles – a record for one pilot.

In 1961 and with work progressing well at Culver City, Jim attended the B-58 combat crew training school at Carswell AFB, Texas, where he graduated first in his class, thereafter becoming the Hughes project test pilot on the YB-58 ASG-18/GAR-9 programme. Hughes also provided fire control officers (FCOs), two of who would occupy the tandem positions behind Jim. Their task was to monitor the entire system and fire the GAR-9. During the course of this programme, Tony Byline, Lyn Gear, John Moore, Jess Le Van, John Archer and later George Parsons and Ray Scalise all became intimately familiar with these duties.

ASG-18 & GAR-9

The AN/ASG-18 employed a high average-power, liquid-cooled, travelling wave tube transmitter chain that consisted of two travelling wave tube amplifiers set in tandem to provide the desired gain, plus analogue circuitry for generating and processing a coherent high pulse repetition frequency waveform. The entire package included a solid-state digital computer for navigation, attack and BIT; integrated controls and displays; missile auxiliaries; an analogue attack steering computer; and an infrared (IR) search and track set capable of cooperative use with the radar.

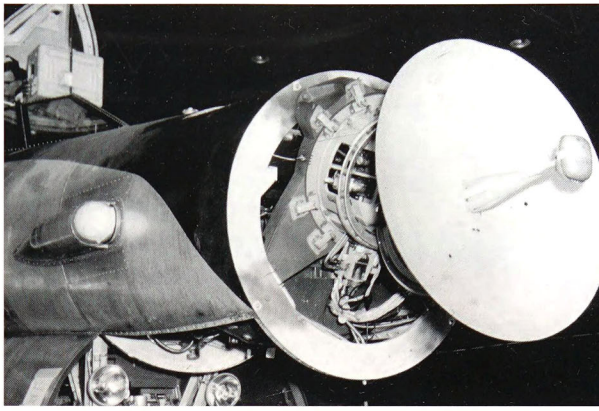
The effective range of the IR system depended upon the point where either it traversed over the horizon or something appeared between the target and the system. All early IR systems used an uncooled lead sulphide sensor-cell and operated in the short wavelength of 2–2.5 microns. This generated countless discrimination problems, so Hughes continued development work in this field, utilizing the F-102 that Jim Eastham flew out of Holloman

▼ YB-58 55-665 nicknamed 'Snoopy 1' was used to flight-test the AN/ASG-18 FCS and GAR-9 (later AIM-47) missile. The aircraft's nose section was extended by almost 7ft to accommodate the new attack radar system. (Jim Eastham)

AFB, and eventually produced a long wavelength sensor cell using an indium antimide cell cooled by liquid argon. This worked in the 3–5 micron range and had an outstanding discrimination capability. The IR system installed in the YB-58 and AF-12 was yet another development and it used a lead selenide cell cooled by liquid nitrogen. However, extensive testing of this system would never be carried out.

On completion of modifications to the YB-58, the programme was moved to the Hughes facility on 'Contractors' Row' at Edwards. Despite the cancellation of the F-108 programme on 23 September 1959, DoD officials decided that the outstanding FCS and missile development programme should continue on a 'stand' alone basis.

With the modified YB-58's first FCF successfully completed, the next order of business was to undertake a BIT check flight of the ASG-18 in the aircraft. During the following missions, the team was tasked to monitor the tracking capabilities of the FCS against Titan and Atlas ballistic missiles launched from Vandenburg AFB. Jim recalls: 'The mission against the Titan was only partially successful because a problem developed in the velocity gate of the ASG-18. But during the next sortie, against the Atlas D, we acquired the missile and tracked it with the ASG-18 until the antenna hit the bumper-ring. The IR tracker was slaved to the radar and it too acquired the target and tracked it until its antenna hit the IR bumper-ring.'



▲ The AN/ASG-18 could use infrared target tracking. A blister to either side of the YB-58's forward fuselage housed the IR tracking sensors. (Jim Eastman)

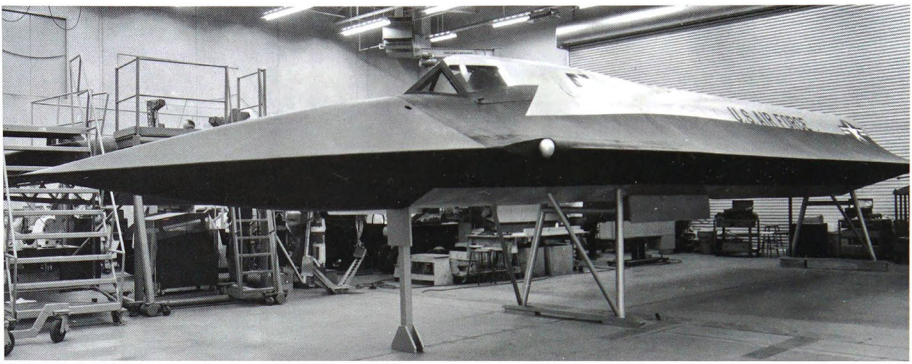
◀ This frame grab shot from a chase aircraft shows the debris field resulting from a GAR-9 missile strike. The target was a QF-80 remotely piloted drone carrying an augmentation pod, the YB-58 having fired the weapon from 23nm. (Jim Eastman)

But progress was slow during this first year, with B-58 accidents throughout the SAC fleet causing numerous groundings of '665. During this off-and-on testing time, a question arose concerning the effectiveness of the ASG-18's ability to detect an extremely low-altitude target. It was soon answered, however, when the system actually locked onto and tracked a B-57 at long range as the target completed a 'touch-and-go' landing at Edwards.

KEDLOCK

Undoubtedly spurred on by the earlier success of his A-12 design with the CIA, Kelly Johnson discussed the possibility of building an interceptor version of the A-12 for the Air Force over 16/17 March 1960, with Gen Hal Estes of Air Force Systems Command and Dr Courtland Perkins, the Air Force Secretary for Research and Development.

Referred to by Kelly as the AF-12, his ideas were keenly received and subsequently forwarded to Gen Martin Demler at Wright Patterson for further discussion and analysis. During late October 1960, Lockheed received a letter of intent for $1 million and was directed to 'go forward with Plan 3A' and produce an interceptor version of the A-12. Equipped with



▲ The YF-12A forward fuselage mock-up. (Lockheed Martin via Tony Landis)

the Hughes ASG-18 FCS and the GAR-9 missile system, the programme was accorded the classified code name Kedlock.

Kelly appointed Rus Daniell to become the project engineer and the seventh A-12 was nominated to become the AF-12 prototype. In December 1960, a Kedlock project group was organized at the Skunk Works; in order to maintain security, it worked independently of the Oxcart team.

A considerable amount of work was necessary to convert the reconnaissance platform into an interceptor, although it's fair to say that most of this was focused around the forebody of the aircraft. Initially these external changes were typified by the creation of a second cockpit in the A-12's Q-bay. The fuselage 'chines' were cut back to incorporate a radome that housed a 40in. radar scanning dish, and four weapons bays were added, cut into the underside of the 'chines'. These would house the FCS (in the right forward bay) and three GAR-9 missiles (two in the left bays and the third in the right rear bay).

On 23 and 24 January 1961, the first meetings with the Air Force's Weapon System Project Team took place at Burbank, where they were briefed on the Skunk Works design and development philosophy. On 31 May, some 15 Air Force officers returned to the plant and completed a review of an AF-12 mock-up; all seemed to be progressing extremely well.

However, by June, wind tunnel tests had revealed serious directional stability problems resulting from the reconfigured nose section and the slightly raised second cockpit. To alleviate the problem, further external modifications were necessary, this time to the rear of the aircraft, where a fixed ventral fin was installed on the underside of each engine nacelle. In addition, a large folding fin was mounted at the rear on the aircraft's centreline. Folding and extension of the folding ventral fin worked out of phase with the cycling of the landing gear, so that when the gear was retracted, the fin extended and vice versa.

Generally the fin-fold system worked well, but on one occasion Lockheed test pilot Bill Weaver found himself flying a YF-12 with a ventral fin that stubbornly refused to fold. Demonstrating great piloting skill and determination, he successfully landed the aircraft and saved an extremely valuable piece of hardware – the fin's profile was considerably modified by the incident

One evening early in 1962, Jim Eastham was at his home in Lancaster, Nevada, when his doorbell rang. He answered to find Lou Schalk – a long-standing friend – at the door. Jim recalls:

At first I thought that Lou had swung by on his way to visit family who lived in

Lancaster; but he said no, he'd come to visit me! I invited him in, poured a couple of 'cold ones' and asked what was on his mind. He said he wanted me to go and work for him. But when I asked him what I'd be doing, he said he couldn't tell me.

I responded by saying, 'Lou, I'm flying the B-58, it doesn't get any better than that!' And Lou said, 'This is a hell of a lot better than that!' So I replied that I was definitely interested! I suspected that Lockheed were developing a new interceptor and that it would be using our weapon system and missile. He arranged for me to have a meeting with Kelly Johnson and I drove down to Burbank.

When I got there, Johnson put his fat finger in my face and said, 'You'll continue to do what you're doing and we'll find something for you to do around here.' And that is the origin as to how I ended up working simultaneously for two companies! I would hasten to add, I didn't receive two base salaries – for the next two years, my primary pay continued to come from the Hughes Aircraft Company.'

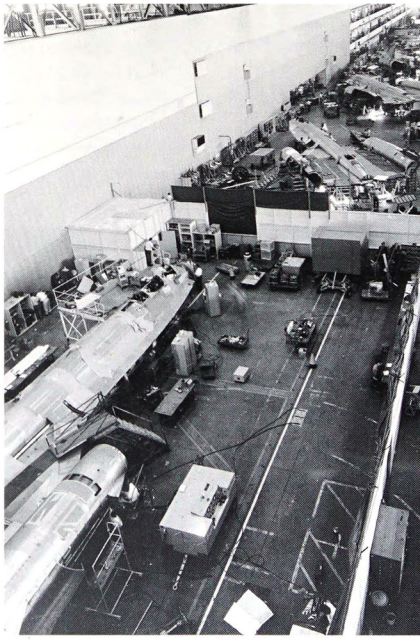
Once an extensive security check had been completed, Jim began spending time with Skunk Works engineers at Burbank, familiarizing himself with the location of switches and other specialist equipment in the AF-12 mock-up.

His second year of flight testing with the YB-58 involved integrating the missile into the aircraft and tailoring it to work with the radar system. This extremely complex task was carried out under the direction of Clare Clausen, the programme manager, and involved some of the finest electrical engineers in the Western world.

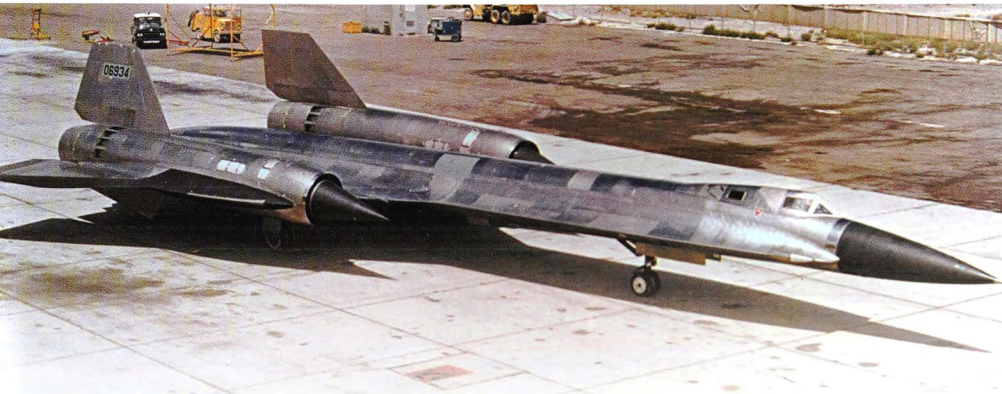
First of all, captive flights were performed, which involved making runs against manned aircraft and checking out the radar and missile system to the point of launch. Subsequent analysis of the recorded data would isolate problems that were apparent to the flight crew during the sortie. Then, after missile separation tests, which included some unguided firings, about six live guided firings were made by Jim and his team in the YB-58 over the White Sands missile range.

By 2 August 1962, Air Force funding had been increased to allow for the modification of three A-12s on the production line, and the major elements of the prototype, assigned Article number 1001, were in the jig at the Skunk Works. As the manufacturing effort continued from December 1962 through to the spring, reservations were muted in some quarters about the security of the Oxcart programme and that of its fighter stablemate, particularly in relation to the latter's fast approaching flight test programme. Edwards certainly appeared to offer the best option for flying, but in the event, 1001 was crated up and trucked to Area 51.

With Jim now spending an increasing amount of time at Area 51, Lou Schalk and Kelly agreed that he should be the first pilot to fly the AF-12, which by now the Air Force had designated YF-12A. Consequently in March 1963, Jim began writing the *Flight Manual*, or 'Dash 1'. This rather complicated volume consisted of 12 sections that covered every aspect of normal and emergency operation and required Jim to move in with the engineering section concerned with each particular subsystem. He also spent a good deal of time with the aerodynamicists; having already flown the A-12, this outstanding engineering test pilot was anxious to learn the differences between the two Skunk Works birds.



▼ Workers involved in the Kedlock programme were not cleared for access to Oxcart, so the three YF-12s were built within an area partitioned off from the rest of the Skunk Works. (Lockheed Martin via Tony Landis)



▲ YF-12A Article 1001 (60-6934) at Area 51 as it appeared on its maiden flight, prior to black paint being applied to the fuselage chines. (CIA via Tony Landis)

OUTLINE DESCRIPTION

The YF-12A was 101ft 8in. long, stood 18ft 4½in. high, had a wingspan of 55ft 7½in. and a wing area of 1,605sqft. The wing featured a leading edge sweepback of 61.25°, it had no dihedral, and its angle of incidence was 1° 2'.

The empty gross weight of Article 1001 was 60,730lb, the specification being 59,422lb, and maximum take-off weight was 127,000lb, with the specification being 124,491lb.

On the ground the aircraft was supported by a tricycle undercarriage with a main wheel track of 37ft 9½in.. The aircraft's centre of gravity (CG) limits were between 16 and 29 per cent of the mean aerodynamic chord (MAC) and its G limits were -1 to +3.6.

Interestingly, the aircraft's maximum allowable airspeed and its design speed were equal, 450kt equivalent airspeed (KEAS). KEAS was used throughout the A-12/YF-12 and SR-71 programmes when speed criteria needed to be followed because aircraft are designed structurally using KEAS and it also enabled one airspeed limit to be specified for all altitudes.

Prohibited manoeuvres were spins and roll rates in excess of 120° per second, and take-off rotation had to be limited to less than 14° or the engine nacelle ventral fins would contact the runway.

▼ Jim Eastham was Lockheed's chief test pilot on the YF-12A: he's pictured here wearing a David Clark S-901 pressure suit. The 'yellow box' to his left is a portable oxygen and environmental control unit. Eastham's personal call sign was Dutch 52. (Lockheed Martin)

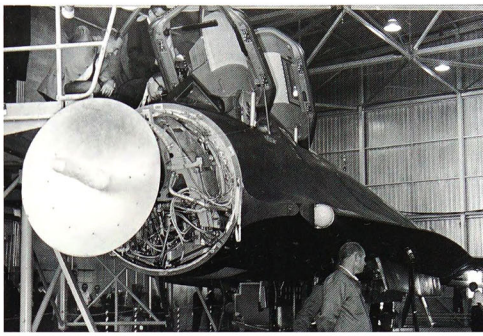
FUEL SYSTEM

The YF-12 used a fuel referred to in the Flight Manual as PWA 523B, more commonly known initially as PF-1, before JP-7 became available Possessing a high flashpoint, it also contained a liquid Teflon additive to lubricate the engine hydraulic pumps and various engine accessories. The fuel density averaged 6.4lb per US gal. Fuel tank capacities were:

Tank 1	936 gallons	5,990lb
Tank 2	1,230 gallons	7,872lb
Tank 3	1,485 gallons	9,504lb
Tank 4	2,132 gallons	13,645lb
Tank 5	2,141gallons	13,702lb
Tank 6	1,950 gallons	12,480lb
Total	9,874 gallons	63,193lb

Fuel was moved from one tank to another using 16,200V, 400-cycle

booster pumps; tanks one and six each had four pumps, while the remaining tanks each had two. Tanks one, three, four and six fed the left engine; tanks one, two, five and six the right. Fuel could be used in either engine using the cross feed control. A jet pump system removed any residual fuel from a tank that had stopped pumping into the feeding tank. For example, when tank one stopped pumping, a jet pump in tank two pumped residual fuel in tank one into tank two.



▲ The Hughes AN/ASG-18 FCS used a massive 40in. array. Note the IR sensor mounted in the shoulder of the cut back chine and the camera located on the right of the raised forward canopy. This photographed cockpit instrumentation for later analysis. (Lockheed Martin)

ELECTRICAL SYSTEM

The YF-12 had an awesome electrical system – it had to, as the ASG-18 alone required 40KVA to operate! To satisfy this veracious appetite, the aircraft was equipped with two 60KVA, three-phase, 400-cycle, 200v, three-phase, 115v single-phase 175A alternators. They were driven by a Sundstrand constant-speed drive turning at 8,000rpm.

Two transformer rectifiers supplied DC power to the aircraft, while a small silver-zinc battery, located in the nose wheel well, provided 15 minutes of emergency DC electrical power. An inverter supplied emergency instrumentation power and lights for about 15 minutes. During normal operation, the inverter furnished power to the stable platform; during emergency operation, this dropped off.

A 40hp compressor ran the ASG-18's cooling package. It had an inrush current that ranged from 500 to 600A and a running current of 100A.

COMMS EQUIPMENT

For communication purposes, the YF-12 was equipped with two Collins ARC-51 UHF radios that provided 1,750 channels, two Collins 618-7 HF single side band radios and an AIC-18 intercom. An ITT ARN-52 with 128 channels provided TACAN capability; an ARN-58 built by GFE equipped the YF-12 with the air component of an ILS; and in the rear cockpit was the APX-46 IFF display.

HYDRAULIC SYSTEMS

There were four hydraulic systems designated Left, A, Right and B. They used a hydraulic fluid known as SP-302, which was a highly de-waxed mineral oil. Nine Vickers pumps were used across the four systems and they each produced a pressure output of 3,350psi. There was one reservoir for each system, located in the main wheel well; in addition, a reserve hydraulic reservoir with a capacity of 10US gals at 500°F provided a standby for the A and B system reservoirs when either dropped down to the 1US gal level.

PREPARATIONS FOR FLIGHT

Once Article 1001 had arrived at Groom Lake, several weeks were spent assembling the aircraft and equipping it with new J58 engines. Little in the way of an FCS was installed at this stage. After a few wrinkles in the electrical system were ironed out, engine runs were made. The hydraulics were checked to ensure they functioned correctly and were leak-free. The SAS was brought on line and checked to ensure it would engage and function properly.

▲ The second YF-12A, Article 1002 (60-6935) parked on the ramp at Area 51 with all four weapons bays and the brake chute doors open. (Lockheed Martin via Tony Landis)

Further ground tests on the J58s involved operating at full power to ensure that their output agreed with Pratt & Whitney's performance data schedule.

Early taxi tests uncovered a slight problem in the brake and damper system. Once this was resolved a high-speed taxi test was undertaken to near take-off speed; when this was reached, the power was chopped and the brake chute was deployed. Having satisfied all the ground requirements and determined that all instrumentation and communication equipment functioned properly, the YF-12 was deemed to be ready for its maiden flight.

On 7 August 1963, Jim Eastham climbed aboard 60-6934 for a first flight that he later modestly characterized as a typical production test flight, chased by Lou Schalk flying an F-104. On that smooth flight, the YF-12's powerplant, control system and SAS were checked for proper operation and the electrical, hydraulic, environmental and pressurization systems were checked as satisfactory; the vertical instrument indicating Mach number and KEAS also functioned well. (SAC generals vetoed this type of instrumentation for the SR-71, in preference for 'old standard' round dials.)

Some minor handling quality checks were conducted, followed by an appraisal of the aircraft's static stability. Checked in all three flight axes, the YF-12 appeared, at least subsonically, to be 'much the same as its Black World stablemates'. Because of its stability, Jim was of the opinion that the aircraft 'carried enough tail'. With all systems functioning well, the power levers were advanced into full military power and the aircraft went supersonic. This presented no problems in either the transonic or low supersonic regions, where handling characteristics were once again assessed as identical to those of the A-12.

After deceleration to subsonic speed, the aircraft was prepared for landing back at Area 51. When the gear was lowered a cockpit light indicated that the ventral fin had retracted – this was visually confirmed by Lou Schalk. The approach phase was characterized as identical to that of the A-12. Concern over available ground clearance for the ventral fins during flare prior to touchdown proved unfounded and the near perfect 'squawk free' test flight ended with the successful deployment of the drag 'chute.

Kelly would later note in his AF-12 log, 'It is the first airplane I've ever worked on where the fire control system was checked out prior to the first flight.' With the first flight completed with flying colours, there was little urgency in getting the YF-12 out to design speed since Lockheed had already achieved the full speed envelope with Oxcart. Instead, time was spent installing the FCS, ensuring that it integrated into the YF-12, and testing the INS.

GOING PUBLIC

With the Oxcart flight test programme now in full swing, and a notable increase in Cygnus test and training sorties, questions were being raised as to how much longer the project could remain hidden. In a secret memo dated 11 January 1963, from the Chief of Security Branch, OSA, addressed among others to the OSA's Assistant Director, Jack Ledford, a course of action was outlined to protect Project Oxcart during 'surfacing of the USAF X-21/R-X Program'. Point 2 of the memo recommended 'a coordinated, timely and thorough briefing of key governmental and industrial officials who may be called upon to respond or react to the initial release of the X-21/R-X Program'. Point 3 of the memo proposed that 'items enumerated in referenced memorandum be immediately coordinated with Headquarters USAF, and promulgated to AFCIG-5 and the Kedlock Project Office at Wright Patterson AFB,' and that these two offices should be the 'focal points within USAF for all Oxcart/Kedlock security procedures.'

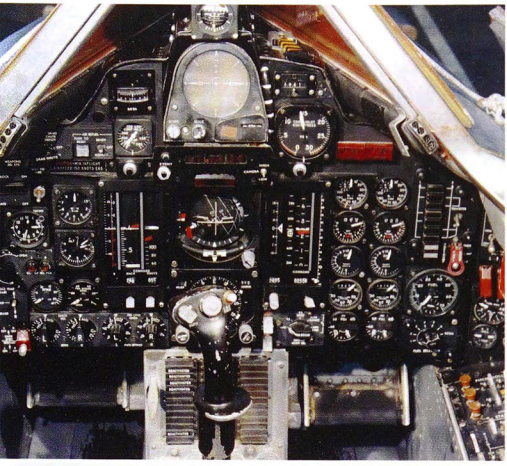
It then went on to advocate that once those with a 'need-to-know' had been briefed by CIA security agents, a briefing should be prepared that would admit the existence of a programme, but which 'intends to publicize a minimum of detail'. For those connected with the programmes, 'Security Rules remain the same, without relaxation concerning the capabilities of our hardware, delivery schedules, names of other contractors, production numbers and state of flight tests. This is the rule, regardless of what you may see or hear through public news media.'

In sub-paragraph 'e' of the memo, its originator recommended, '(probably subsequent to the release) change the names Oxcart and Kedlock. The new Oxcart designation will in future refer only to individuals witting of the CIA, A-12, sponsorship and operation. The new Kedlock designation will be used for all individuals whose need-to-know is limited to the USAF version(s) of the A-12.' In a hand-written note adjacent to where Jack Ledford was to sign his approval for the document, he wrote 'Prepare but do not execute. Question of surfacing is still in doubt.'

A curt top secret memo dated 20 May 1963 (reflecting the friction between the OSA and NRO at the time) addressed to Director, National Reconnaissance Office (Brockway McMillan) and written by Herbert 'Pete' Scoville (CIA, Deputy Director for Research), entitled *Proposal for Surfacing an LRI* [Long Range Interceptor] *Prototype as Cover for the Oxcart Programme*, noted in point 3:

> The purpose of this memorandum is to restate the grave concern expressed in our previous memorandum with regard to the possibility of an untoward incident which could result in an uncontrolled surfacing of the Oxcart vehicle. Since that paper was written, there have been several minor incidents involving mechanical malfunctions and sightings of the A-12 which might have developed into serious problems had fortune not otherwise dictated. In addition, during this period, escalated activity in the R-12 [SR-71] procurement program has, as we anticipated, generated increasing speculation both in the industry and in the Air Force regarding many facets of the programme.

▼ 60-6934 pictured later during the flight-test programme with an overall black colour scheme. (Lockheed Martin via Tony Landis)



▲ The front cockpit of the YF-12A shows its strip-type instrumentation for airspeed and altitude. (Lockheed Martin)

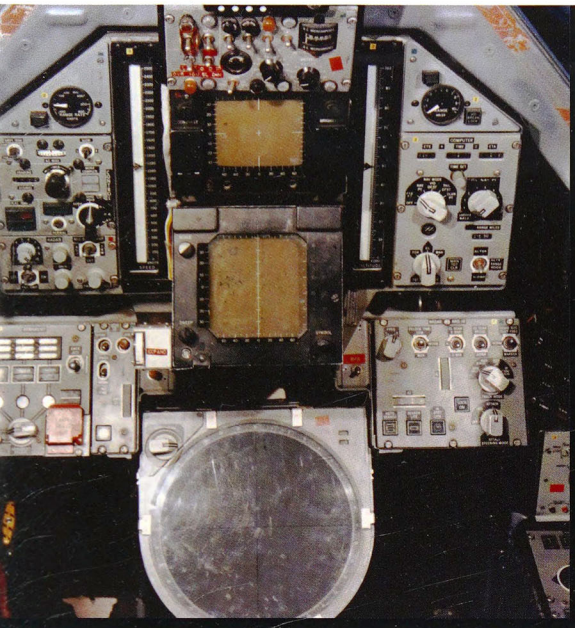
In point four, the final paragraph, Scoville continued: 'In light of the foregoing, I feel that it is not only appropriate but essential at this time to request a reconsideration of this problem by the NRO with a view toward making recommendations to the Ad Hoc Cover Committee and higher authorities as to whether we should continue with the current contingency plan or take action to implement the proposed LRI surfacing.'

This contentious issue needed to be resolved. Undoubtedly Scoville's tenacity ensured that minds remained focused on the problem at hand, and, sure enough, things began to move; the first stage was the transfer of all management functions relating to Program D (which had taken on the AF-12) and the R-12 to the Air Force. This brought with it a change in security. Another secret memo, dated 11 July 1963, addressed to Eugene Zuckert, Secretary of the Air Force and penned by Gen Schriever, Commander US Air Force, noted, 'The change in security would publicly disclose (2d level) the existence of the development of the AF-12 and/or R-12.'

But concerns continued, as witnessed in point 10 of a classified CIA diary note dated 27 September: 'At the executive meeting this morning the Director reported that Mr Hotz, the editor of *Aviation Week*, had been to see General Carroll. He told General Carroll that he had good information that another airplane, a follow-up for the U-2, had been developed. Carroll apparently told Hotz that it would not be in the national interest to print anything on this, in response to which Hotz said that he was willing to sit on it provided everyone else did. In other words, he was not about to be scooped. The Director is seriously concerned that Oxcart is going to blow sooner or later.'

On Friday 29 November 1963 (one week after the assassination of President Kennedy) the new president, Lyndon B. Johnson (LBJ), convened a meeting of the National Security Council (CIA Director John McCone, SecDef Robert McNamara, SecState Dean Rusk, Special Assistant McGeorge Bundy and FAA Chief Najeeb Halaby). The main question on the agenda was whether to, or how to, 'surface' the technological triumph of Oxcart. McCone counselled delay, but was in favour of some sort of press release in connection with the planned development of a supersonic transport (SST) airliner; Halaby agreed. McNamara was in favour of total exposure because the money already allocated to Oxcart would weaken the case for funding the B-70 programme and other expensive Air Force projects that he did not like.

At that point, Lyndon Johnson was informed by Bundy that Kennedy had been opposed to the early release of information pertaining to Oxcart, preferring instead to hold off its public debut until the following year so as to strengthen his re-election campaign. Bundy was attuned to the politics of 'high-tech projects' and spoke against early release because of potential criticisms likely to be levelled at the new president for attempting to make political 'capital' out of a great intelligence secret. Consequently, LBJ decided to 'keep his powder dry' until the run up to the 1964 elections. However, after Republican candidate Senator Barry Goldwater accused the Democrats of failing to sponsor new aircraft projects, Johnson concluded that the earlier-than-planned release of some form of statement was inevitable, and directed his advisors to prepare a formal announcement about the hitherto black project. Kelly was asked to work on the draft that LBJ would use, and noted in his diary on 25 February that he 'proposed the terminology "A-11" as it was the non-anti-radar version.'



▲ An 818lb AIM-47 is gently raised into a weapons bay. (Lockheed Martin via Tony Landis)

◀ The FCO's cockpit instrumentation was dedicated to control of the YF-12's formidable weapons system. Three displays provided target, ranging and position data, with radar control panels to the left of the square displays, armament controls below these, radar and IR controls opposite to their right, and computer controls above these. The FCO was also provided with airspeed (on the left) and altitude information (on the right) via vertical tapes. (Lockheed Martin)

BACK AT AREA 51

While all this politicking was taking place in far-away Washington DC, Jim Eastham and flight test engineer John Wallace got airborne in 60-6936 for another test sortie. The date was 3 February 1964, and this time the test card directed that they should complete the very first heat soak of a Blackbird. To achieve this, the flight was to be conducted at Mach 3.16 for precisely 10 minutes.

The test procedure was followed to the letter, but on recovery back at The Ranch, an inspection revealed that due to an error in the pitot static system, Jim had exceeded Mach 3.2. Consequently, the aircraft had encountered considerably higher stagnation temperatures, which had damaged practically all the electrical wiring. It would be several months before '936 would fly again, and during the intervening period events on Capitol Hill caught up with the programme.

On 29 February 1964, just four days after Kelly's diary entry concerning his work on a draft statement, President Johnson made the following announcement:

> The United States has successfully developed an advanced experimental aircraft, the A-11, which has been in sustained flight at more than 2,000mph and at altitudes in excess of 70,000 ft. The performance of the A-11 far exceeds that of any other aircraft in the world today. The development of this has been made possible by major advances in aircraft technology of great significance to both military and commercial applications. Several A-11 aircraft are now being flight-tested at Edwards Air Force base in California.

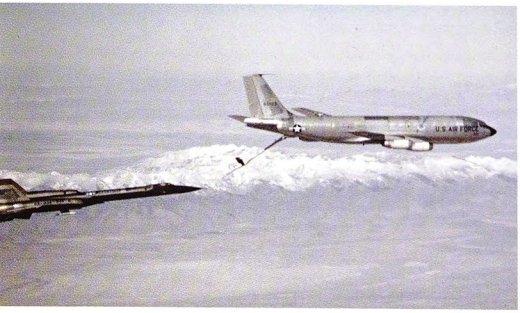
▲ 60-6934 showing the extended centreline ventral fin . Note the streamlined camera fairings on the underside of each nacelle; the cameras recorded missile separation imagery. (Lockheed Martin via Tony Landis)

The existence of this program is being disclosed to permit the orderly exploitation of this advanced technology in our military and commercial planes. This advance experimental aircraft, capable of high-speed and high-altitude and long-range performance at thousands of miles, constitutes the technological accomplishment that will facilitate the achievement of a number of important military and commercial requirements. The A-11 aircraft now at Edwards Air Force base are under extensive tests to determine their capabilities as long-range interceptors. The development of supersonic commercial transport aircraft will also be greatly assisted by the lessons learned from this A-11 program. For example, one of the most important technological achievements in this project has been the mastery of the metallurgy and fabrication of titanium metal which is required for the high temperatures experienced by aircraft travelling at more than three times the speed of sound. Arrangements are being made to make this and other important technical developments available under appropriate safeguards to those directly engaged in the supersonic transport program.

This project was first started in 1959. Appropriate members of the Senate and House have been kept fully informed on the program since the day of its inception. Lockheed Aircraft Corporation, at Burbank, California, is the manufacturer of the aircraft. The aircraft engine, the J58, was designed and built by the Pratt & Whitney aircraft division, United Aircraft Corporation. The experimental fire-control and air-to-air missile system for the A-11 was developed by the Hughes Aircraft Corporation.

In view of the continuing importance of these developments to our national security, the detailed performance of the A-11 will remain strictly classified and all individuals associated with the program have been directed to refrain from making any further disclosure concerning this program.

▼ Article 1001 undertakes air-refuelling tests early in the flight-test programme. (Lockheed Martin via Tony Landis)



I do not expect to discuss this important matter further with you today but certain additional information will be made available to all of you after this meeting. If you care, Mr Salinger will make the appropriate arrangements.

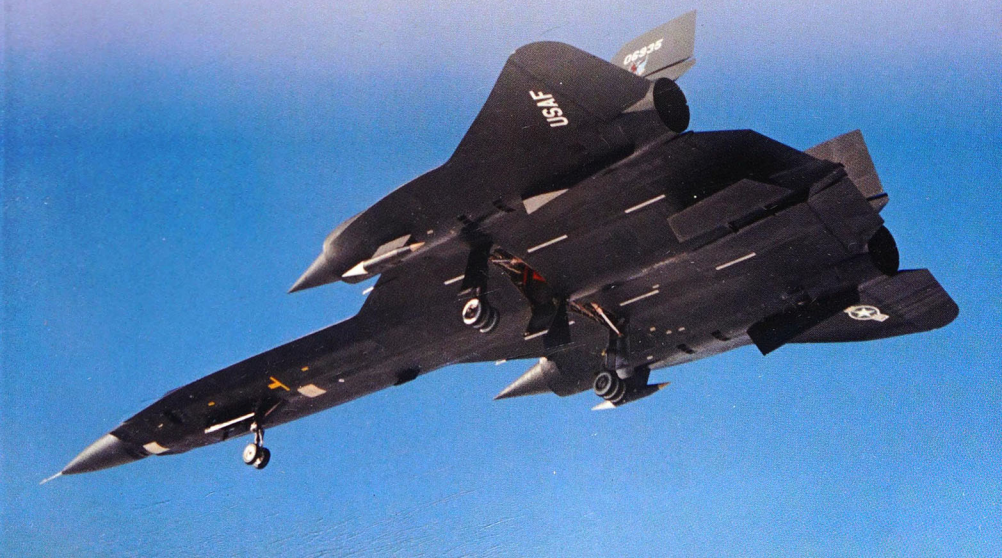
Kelly noted in his diary, 'Pres. Johnson announced the AF-12. Twenty minutes after he did this, we flew the two birds from the Area to Muroc.' The two flyable aircraft, 60-6934 and 60-6935, were positioned to Edwards AFB (which had been known as Muroc until the late 1940s) by Lou Schalk and Bob Gilliland, and the event was witnessed by just a few dozen maintenance staff

who happened to be at work that Saturday morning. Lou Schalk remembers taxiing to the assigned hangar as eyes bulged and heads turned in utter disbelief at the sight of the two sleek aircraft, the like of which hadn't been seen before by anyone outside the programme, with the possible exception of a few desert dwellers and incredulous airline crews.

Lou continues, 'Our supposed low-key, rather laid-back positioning flight lost a touch of elegance when, to aid push-back into the hangar, we turned the aircraft through 180° at the entrance. This turn-around manoeuvre sent hot engine exhaust gases into the hangar that caused the overhead fire extinguisher valves to open. These valves were big – like the flood valves on the hangar decks of aircraft carriers. The desert hadn't seen so much water since Noah's embarkation!'

Once its re-wiring work had been completed, aircraft 60-6936 joined its two stablemates at Edwards and the now overt programme continued in a totally new environment. Suddenly, it appeared the US Air Force had virtually matched, man-for-man, all the contractors involved on the programme and it began to look to the civilian test force that the Air Force was trying to take over the entire project. The move also caused logistical headaches, as most of the expertise was still based at Area 51. Several people intimately involved in the project have said that the YF-12 was considered the stepchild of the Blackbird family, and received neither the emphasis nor the backing from Lockheed management enjoyed by the two reconnaissance variants. Notwithstanding these 'ripples on the mill pond', the first order of business shortly after arriving at Edwards was to install and make operational the new, electrically controlled air inlet system. Once installed, it took Jim Eastham just three months to complete the envelope expansion programme.

Jim flew all of these flights in the Lockheed-operated prototype, 60-6934. On the first, a minor problem occurred as the aircraft approached its design speed of Mach 3.2, which resulted in a directional oscillation. This discrepancy was noticed immediately and acceleration terminated. On return to Edwards, the cause was found to be instability in the inlet controls; as the aircraft yawed in one direction, both spikes reacted to the change as a function of the Beta angle. With the problem identified, Jim attained design speed during the next flight.

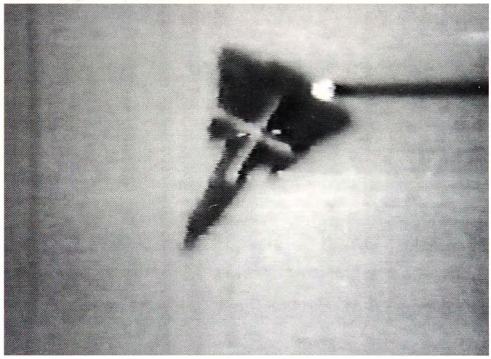


▼ Article 1002 (60-6935) on approach to Edwards AFB. With the landing gear extended, the ventral fin has folded to provide ground clearance. Note the Aerospace Defense Command insignia on the tail. (AFFTC History Office via Tony Landis)

▼ First flown on 13 March 1964, Article 1003 (60-6936) was photographed here over the Rockies. The cut-back chine modification to accommodate the radome is readily apparent. (Lockheed Martin via Tony Landis)

◀ AFSC-operated JQB-47E 53-4256 had been with the 3214th Operational Maintenance Squadron (OMS) at Eglin AFB before being placed in storage at Davis Monthan AFB on 20 August 1968. Mission markings on the aircraft's nose indicate three missions against Kedlock. (Normal Taylor via Tony Landis)

In April 1965, Jim Eastham flew a number of profile-proving sorties that would later allow Air Force crews to fly the YF-12 into the record books. By no means a coincidence, the date chosen to establish these records was 1 May 1965, five years to the day that Francis Gary Powers had been shot down by a Soviet SA-2 missile. In this very public manner the United States was able to aptly demonstrate that over the intervening period it been far from asleep and that it once again ruled the skies. Colonel Robert L. 'Fox' Stephens flew YF-12A 60-6936 to a new absolute altitude record of 80,257ft (24,390m), and Col Walter Daniel took the absolute speed record over a 500km closed course and also obtained the 1,000km closed course record (see Appendix 9 for further details).



▲ This poor-quality image is a frame-grab from the powerful ground-based tracking cameras at Edwards that videoed the right engine fire and subsequent loss of YF-12A 60-6936 on 24 June 1971. Note the large white cross that was applied to the aircraft's underside when it secured a number of world absolute speed and altitude records some six years earlier. (USAF via AFFTC)

On 1 June 1965, the joint SR-71/YF-12 Test Force was formed at Edwards. Comprising Lockheed and Air Force personnel, it was re-designated as the 4786th Test Squadron on 16 June 1970.

Lockheed test pilot Bill Weaver found himself in the unenviable position of flying a YF-12 with a ventral fin that stubbornly refused to retract. Demonstrating great piloting skill and determination, he successfully landed the aircraft and saved an extremely valuable piece of hardware – but the fin's profile was considerably modified by the incident.

With much of the 'pick and shovel work' completed in the YB-58, the ASG-18 and the GAR-9 missile were quickly integrated into the YF-12, where the system transcended its predicted performance figures, although the highly instrumented test aircraft never carried a full missile load.

During the first missile separation test, on-board cameras showed the missile incorrectly aligned; had the rocket motor ignited, the missile would probably have ended up in the forward cockpit! Adjustments were made and the remainder of the test programme proceeded extremely well. Approximately 12 missile firings were made from the YF-12, seven by Jim and the remainder by Air Force crews. An indication of the system's operational potential can be gauged from a test flight on 25 April 1966, in '934 from Eglin AFB, Florida, over the Gulf of Mexico, as Jim Eastham now recalls:

▲ With Kedlock cancelled, 60-6935 was delivered to Wright-Patterson AFB for permanent display. It remains at the USAF Museum as the only surviving example of its type. (Lockheed Martin)

Following take off, we accelerated in a general southwest direction and made a right turn on to an eastbound heading for the 'hot run'. George Parsons, my FCO, acquired the target, which was at about 1,000ft, Mach 0.6 and heading west at a range of 130nm. At that time we were at Mach 3.2 and 75,000ft. Even though we were being vectored, we also ran the mission using the modified close-control feature of the ASG-18 weapon system and tracked the target at the exact 12 o'clock position. Our closure rate was Mach 3.8 and essentially we had an altitude differential of 75,000ft! We went through the mission prep stage and the launch was made at approximately 53nm. The missile guided to impact on the left horizontal stabilizer of the QB-47. At the time of impact we were looking down 73° at the target!'

The unarmed missile hit and destroyed approximately 4ft of the B-47's tailplane. It seems that all but one of the seven launches made by the Lockheed crew were deemed to be a success – the failure of one of the sorties was attributed to a missile gyro system failure. Perhaps not surprisingly, the Air Force was extremely impressed. Aerospace Defense Command (ADC) calculated that it would require 96 of the big fighter's production version– designated F-12B – to replace its aging fleet of F-102 and F-106 interceptors.

With a force this size, ADC officials were confident that they could provide protection to the entire United States against incoming high-speed, low-level bombers by stationing three squadrons of 16 aircraft each on the east coast at Otis AFB, Maryland and another three squadrons of 16 at Paine AFB, Washington to protect the west coast. Another important facet of the F-12B was its

re-attack speed, which was much faster than for example the Convair F-106, which required double the time to reposition itself on a subsonic bomber compared with the F-12; in the case of a supersonic bomber, the F-106's time requirement was four times greater. But it was not to be. Instead, political shenanigans and a long-simmering feud over the appropriation of defence funds between the SecDef, Robert McNamara, and the Air Force deteriorated into a bitter fight.

The war of words between the Air Force and its political masters had begun in April 1964, when the head of ADC, Gen Herbert B. Thatcher, said that he would like to have a large IMI fleet operational by 1967. The root of these comments was engrained in his observations that the DoD had decided not to proceed with such a programme despite giving the impression that such a development was under way via the YF-12A. In truth, McNamara preferred the F-106X proposal after a national intelligence estimate showed it to be the most cost-effective answer to the predicted Soviet bomber threat. As a result, on three separate occasions over three years, he took the unprecedented step of actually denying the Air Force access to $90 million worth of funds that had been appropriated by Congress to begin F-12B production.

Questioned during a joint hearing of the Senate Armed Services Committee and Appropriation Defence Sub-Committee, McNamara said, 'I feel quite confident that it is not necessary to appropriate money that can't be justified for the weapon system itself simply to keep the production line open.' These flagrant delaying tactics undoubtedly protected funds earmarked for the B-70 bomber and the F-106X (the latter programme eventually producing the superlative F-15 Eagle).

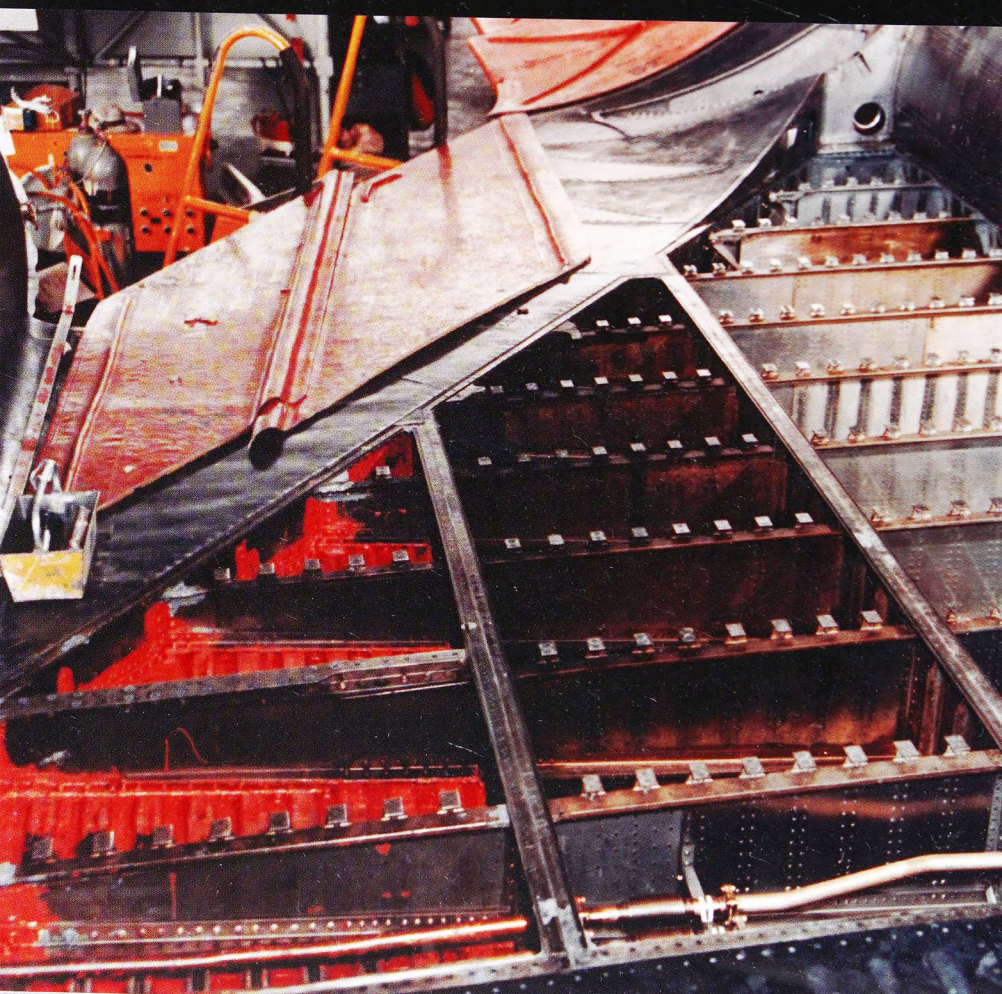
Consequently, in July 1966 Kelly was directed to 'give up further flying of the YF-12As'. Things continued to deteriorate and on 5 August 1966 Kelly noted in his log, 'We have laid off half of our test crew on the YF-12A and are maintaining only enough people to store the airplane or send it to Burbank. We are very near the end of this program.'

Despite this rather bleak outlook, Kelly still remained hopeful that F-12B production would be reinstated, and even as late as 27 January 1967 he was still awaiting a final decision from the Air Force. In March of that year, Kelly's optimism seemed justified when Colonel Ben Bellis led him to believe that the F-12B proposal had been accepted by the Air Force. On 13 November 1967, Kelly was asked to carry out studies into converting the ten now retired Oxcarts and also ten SR-71s into fighters. These studies envisaged the installation of Sparrow missiles and a Westinghouse radar, but nothing further came of this.

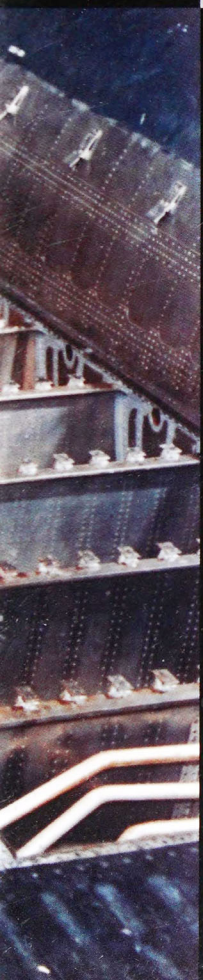
In late December Kelly received a call from the SPO instructing him to shut down all AF-12 studies immediately and cancelling all other ADP air defence programmes with the exception of a vulnerability study that was to be transferred to the SR-71. On 5 January 1968, the Skunk Works received official notification from the Air Force, closing down the F-12B. The YF-12A programme formally ended on 1 February. This was followed up four days later by a letter from the Air Force instructing Lockheed to destroy all A-12/F-12 and SR-71 tooling. Consequently the large jigs were cut up and duly sold for scrap at 7.5cents per lb. As Kelly noted in his log, 'Ten years from now the country will be very sorry for taking this decision of stopping production on the whole Mach 3 series of aircraft in the USA.'

With the programme cancelled, all three YF-12As were placed in storage at Edwards, but this was not quite the end of the story. The loss of SR-71B '957 prompted an interesting piece of aviation surgery. After ablation of its fuselage forebody, the rear section of YF-12A Article 1001 was grafted to the front fuselage of an SR-71 static test specimen to create 'The Bastard', 64-17981. This so-called SR-71C replacement trainer first flew on 14 March 1969. Three test flights were made in two days before the aircraft was delivered to Beale, where it was used as a stand-in whenever the surviving trainer, '756, was undergoing Periodic Depot Maintenance (PDM).

CHAPTER 8



TECHNICAL

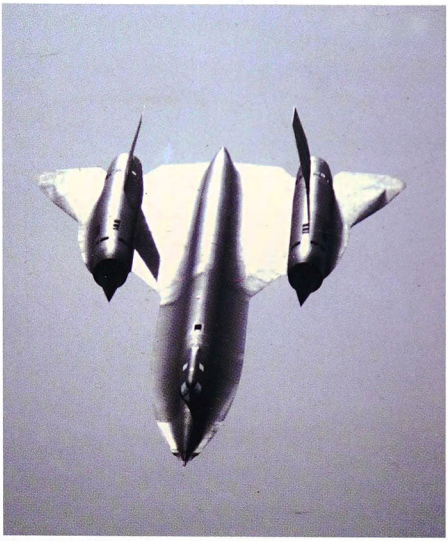


The ambitious nature of Oxcart cannot be overstated. When E. M. Land of the Polaroid Corporation presided over those six historic meetings between 1957 and 1959 that led to the A-12, the best frontline fighters of the day were the early century-series jets, like the F-100 Super Sabre and F-101 Voodoo.

In a single bound, it was proposed that the A-12 would operate routinely at double the altitude and treble the speeds of those contemporary fighters. Therefore, its designers and engineers had to master not only the many daunting problems associated with high-altitude, high-Mach flight. They also had to employ the latest techniques and materials to reduce the A-12's RCS to produce what can now be regarded as the world's first operational stealth aircraft.

In an incredible feat of engineering brilliance, Lockheed matured the A-12 into a frontline reconnaissance gatherer, but also ran evolutionary programmes to create the D-21/M-21 combination, YF-12 and SR-71 from essentially the same airframe. That it did this under the strictest of security is all the more astounding. While much of the following information is applicable to all types in the 'Blackbird family', it is based on arguably its most significant member, the SR-71.

◀ To attach thin titanium skin to heavier wing structure, simple stand-off clips were developed. These gave structural integrity while also providing a heat shield between components with very different expansion rates. (Lockheed Martin)



▲ The unmistakable planform of the SR-71 was characterized by its aft-body delta wing, two large engine nacelles and forward fuselage chine. (Paul F. Crickmore)

GENERAL LAYOUT

The exterior of the SR-71 was characterized by an aft-body delta wing with two large engine nacelles, each mounted at mid-semi-span. Two all-moving fins were located on top of each nacelle, canted inboard 15° from the vertical to reduce the aircraft's radar signature and aid in controlling excess offset yaw during single-engine flight. A large, aft-moving inlet spike or centrebody protruded forward from each engine nacelle, used to regulate mass airflow to the Pratt & Whitney J58 engines.

Mission sensors were housed in a detachable nose section and in equipment bays located in the underside of the chine (a boat-like hull-form) that extended along both sides of the long fuselage forebody. The aircraft was flown by a pilot and reconnaissance systems officer (RSO), wearing full pressure suits and sitting in tandem.

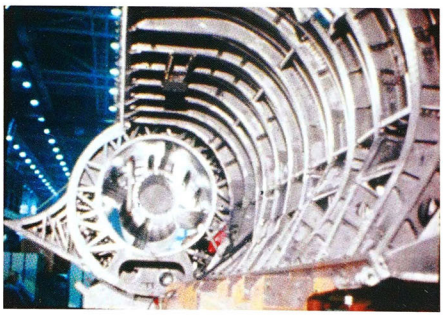
The wing was arranged in box sections, one outboard of the engine nacelle and two inboard. The inboard sections were positioned one forward and one aft, and were separated by a 1m-wide compartment housing the main gear bay. The front and rear beams of the inboard box sections provided support for the main gear.

The outboard wing leading edge featured 5° of conical camber to reduce bending movement and torsion, moving most of the aerodynamic load in this section to the rear of the nacelle. The nacelle, considered an integral part of the wing, acted as a chordwise beam and torque tube, transmitting these aerodynamic loads forward and redistributing them via the nacelle rings to the forward and aft box sections. The thin, biconvex wing had a leading edge sweep of 52.62° and a trailing edge forward sweep of 10°; it joined the mid-fuselage with a slight negative incidence.

The aircraft's loaded gross weight varied from between 135,000 to more than 140,000lb and zero fuel weight varied from 56,500 to in excess of 60,000lb.

The fuselage can be described in three sections. First the forebody: since the nose section was interchangeable for mission flexibility and structurally independent of the fuselage, the forebody can be said to extend from the tip of the forward cockpit to a point perpendicular to the intersection of the leading edge of the wing, a point known as fuselage station 715. The structure consisted of a ring-stiffened cylinder fitted with longerons at the top, bottom and side, and modified to the extent necessary to accommodate the cockpit, equipment compartments, nose gear well, air refuelling receptacle and two fuel tanks.

▼ A view from inside the left engine nacelle looking forward at the aft section of the inlet spike's body. (Lockheed Martin)



The mid-section, which extended to the main undercarriage well, contained fuel tanks that stretched laterally into the forward wing box area. The main gear bay dissected the forward and aft wing boxes and formed two structurally independent elements. Inboard, aerodynamic and bending loads at the root were carried by the fuselage longerons located at the top and bottom of the centreline, whereas outboard loads were borne by the wing attaching structure.

The aft fuselage section began at the rear of the main gear bay and tapered into the tail, but excluded the brake 'chute receptacle. The entire area, together with the aft wing section, was used to provide two more large fuel compartments. To reduce trim drag at high Mach numbers, the nose section canted upwards some two and a half degrees. Fuselage structural rigidity was enhanced by the use of ring stiffeners, while fairings fitted between the fuselage and wing root, although not part of the structure and supporting local air-loads only, provided a convenient cavity within which to house electrical and plumbing lines.

▲ The aft and mid-fuselage section is moved by crane to an area where the forward and aft inboard wing sections will be attached. (Lockheed Martin)

An inherent aerodynamic design characteristic of delta-winged aircraft resulting from their large root chord is a major rearward shift of the centre of pressure (COP) during acceleration from subsonic flight. This results in the pilot having to apply an increasing amount of drag-inducing elevon to trim the aircraft and reduce the pitch moment.

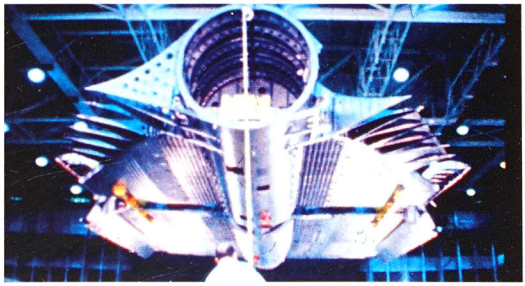
A key aerodynamic asset in reducing trim drag in the SR-71 was its chine. With the fuselage forebody accounting for 40 per cent of the aircraft's overall length, the chine acted as a fixed canard surface, producing lift as a function of the square of its speed, thereby becoming more effective with increasing Mach number. This, when combined with the long moment arm of the forebody in relation to the centre of gravity, greatly reduced the rearward translation of the COP, which in turn reduced the amount of elevon necessary to balance these forces and so reduced trim drag.

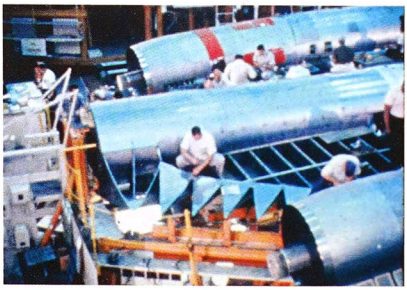
The chine also offered the SR-71 benefits when manoeuvring at low speed. As incidence increased, there occurred an increase in suction over the upper surface, particularly at the leading edge wing tip. This created an adverse pressure gradient behind the leading edge that separated and rolled into a vortex, turning downstream to be shed at the wing tip. As incidence further increased, the separated flow moved inboard until the entire leading edge inherited a continuous vortex. This allowed for both a lower approach speed and the use of smaller vertical surfaces to retain minimum longitudinal stability, while additionally reducing rolling moment due to yaw at high angles of attack. The maximum trimmed lift/drag ratio at subsonic speed was approximately 11.5 and at Mach 3 it was 6.5.

▼ A 1m-wide gap between the two inboard wing sections accommodates the main undercarriage. (Lockheed Martin)

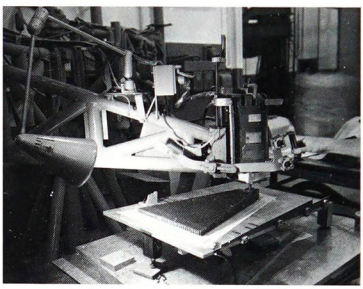
MATERIALS

In the near-vacuum conditions at 83,000ft, the ambient air pressure is about 0.4psi and the temperature hovers around -55°C. However, cruising in afterburner at its design speed of Mach 3.2 – covering a mile every 1.8 seconds and faster than the muzzle velocity of a 30-calibre bullet – there remained enough air resistance to send the SR-71's airframe temperatures rocketing. External to the cockpit areas, these registered 220°C, about the hottest setting on a domestic oven; wing leading edges became hotter than a household





▲ The serrated titanium wing leading edges were designed to accommodate temperature-resistant RAM. (Lockheed Martin)



▶ A monocoque wing fillet of RAM undergoing construction. (Lockheed Martin)

soldering iron and the outside nacelle areas adjacent to the afterburner section reached 560°C.

For this reason, thermodynamic factors influenced both design and construction of the SR-71 more than any other aircraft of its time. Only titanium and stainless steel could withstand operations in this 'thermal thicket', and as titanium weighs only half as much as the latter, 93 per cent of the SR-71's structural weight consisted of aged titanium B-120 alloy (B-120/Ti-13V-11Cr-3A1). The remaining seven per cent – the fins and triangular wedges that framed the outer edges of the aircraft – were of composite construction. Made from a mixture of asbestos and epoxy, they provided high-temperature, radar absorbent characteristics to reduce the aircraft's RCS.

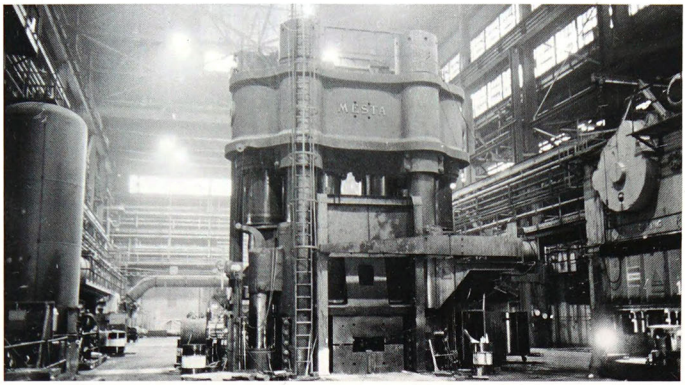
The next problem facing the Skunk Works team was from where to source the precious titanium. It conducted a worldwide search and, after setting up dummy companies, managed to surreptitiously purchase titanium sponge from one of the world's leading exporters – the Soviet Union! The subterfuge and circuitous supply routes were so successful that the Soviets never discovered that they were inadvertently supplying the material essential for constructing an aircraft that was being built specifically to spy on them.

The decision to use titanium represented a milestone in the continuing evolution of aviation materials and by necessity led to the invention and perfection of many new airframe assembly procedures. Initially, the titanium age-hardening process required 70 hours to achieve maximum tensile strength (up to 200,000psi), but careful processing techniques by the Skunk Works reduced this to 40 hours.

Over-aging titanium causes brittleness and some early coupons fell foul of this, shattering when dropped from desk height. Lockheed believed the problem to be hydrogen embrittlement produced during the heat treatment process, but despite the close co-operation of its supplier, Titanium Metals Corporation (TMC), the case remained unproven and unresolved until Lockheed replaced its entire acid pickling facility with a unit identical to that used by TMC.

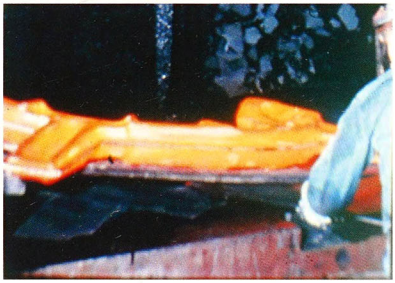
A rigorous quality control programme was introduced. For every batch of ten or more parts processed, three samples became controls for the remainder. One was strength-tested to destruction, another tested for formability and the third held in reserve in case reprocessing should be required. With more than 13 million titanium parts manufactured, data was stored on all but a few early samples.

Titanium is a metal with several idiosyncrasies and it wasn't long before Lockheed became well acquainted with all of them. For example, it is not compatible with chlorine, fluorine or cadmium. So a line drawn on a sheet of titanium with a Pentel pen will eat a hole through it in about 12 hours; perhaps not surprisingly, all Pentel pens were called in off the shop floor. Early spot-welded panels produced during the summer had a habit of failing, while those put together in the winter lasted indefinitely. Through diligent detective work, it was discovered that to prevent the formation of algae in summer, the Burbank water supply was heavily chlorinated. Thereafter, all titanium parts were washed in distilled water. During prolonged



◀ A 50,000-ton press, developed and built by Wyman Gordon, was used in the manufacture of the main nacelle rings. (Lockheed Martin)

▼ Initially nacelle rings were made from 30 parts and required 487 hours to assemble. As shown here, they were later manufactured from a single forging weighing 325lb and then machined on advanced profilers that enabled the part to be finished in 150 hours. (Lockheed Martin)



heat soak tests, bolt heads began dropping off various installations; this, it was discovered, was caused by tiny cadmium deposits left after cadmium-plated spanners had been used to apply torque. Needless to say, all cadmium-plated spanners were removed from toolboxes.

Lockheed awarded the Wyman Gordon Company a $1-million contract for a research programme into methods for forming complex structural pieces from titanium, such as the gear legs and engine nacelle rings. The result was a unique hot-forging process that used a 50,000-ton press to force the metal into the desired shape. Lockheed designed high-speed cutting tools that were then used to machine such items. Initially, a drill bit would cut just 17 holes in the hard metal before it was ruined, but by the end of the programme Lockheed ADP had developed drills that could bore 100 holes and then be successfully re-sharpened. The Skunk Works even develop a cutting fluid that, as well as eliminating the corrosive effects of many similar fluids, permitted metal removal at double the normal rates.

The worked parts were then 'pickled' (chemically descaled) and to prevent them from going under-gauge in the acid baths, metal gauges two thousandths of an inch thicker than required for the final part were used. After cleaning, a pre-assembly inspection was carried out and the relevant segments assembled on spot-welding machines. To prevent oxidization, welding was conducted with the parts in a neutral nitrogen gas environment inside specially constructed chambers.

During a test undertaken to study thermal effects on large titanium wing panels, a sample 4ft by 6ft was heated to the computed heat flux expected in flight; it resulted in the specimen warping into a totally unacceptable shape. Kelly Johnson overcame the problem by pressing chordwise corrugations into the outer skins; upon reaching the designed heat rate, the corrugations merely deepened by a few thousandths of an inch and on cooling returned to their original shape. Kelly commented at the time that some accused him of 'trying to make a 1932 Ford Trimotor go Mach 3', but the concept worked well.

Another thermodynamic challenge to overcome was that of differential heating across various parts of the interconnecting structure. For example, from a uniform start temperature of 27°C, eight minutes after acceleration a wing spar cap would reach 77°C, the spar web 102°C and the wing skin 177°C; it took another 16 minutes before all three components were

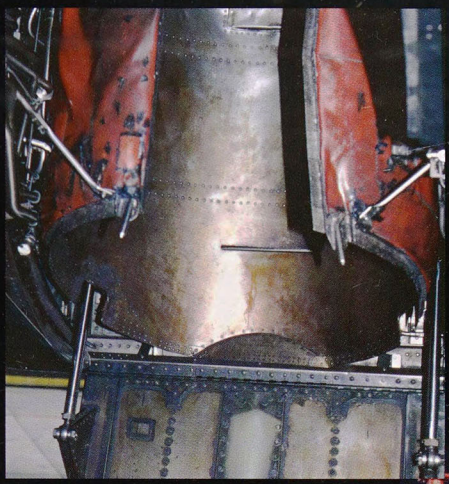
▶ Ben Rich was the Skunk Works' chief thermodynamicist and worked on all the Blackbird programmes. When Kelly Johnson retired in 1975, Ben succeeded him. (Lockheed Martin)

within 8°C of one another. The problem was how to attach a thin sheet of titanium to a much bulkier substructure without the former buckling and tearing. As ever, the Skunk Works developed an innovative solution; a standoff clip provided the anchor mechanism to the substructure, while also creating a heat shield between adjacent components.

The SR-71 was painted black not to make it look sinister or menacing, but in an attempt to further reduce airframe temperatures. As stated in Kirchoff's law of radiation, a good absorber is a good emitter, and a good absorber is a black body. Since convective heating decreases with increasing altitude and radiation is independent of height, it was useful to harness this radiation component when cruising above 70,000ft. Experiments demonstrated that black paint provided an emissivity value of 0.92 compared to 0.38 for bare titanium. In addition, it was estimated that a black 'overcoat' would actually reduce temperatures by between 15 and 30°C and this, it was felt, was well worth the 60lb weight penalty imposed by the paint. Finally, black also helped reduce the aircraft's visual signature when cruising at the inky-black altitudes of near space over 'denied airspace'.

The Air Force was obliged to comply with the rules of the 1907 Hague Convention, however, which stipulate that military aircraft must bear conspicuously placed national insignia (which would necessitate using non-heat resistant paint). Adding a touch of humour to an otherwise serious matter of international diplomacy, Ben Rich, who was chief thermodynamicist at the time, asked, 'Who'll be up there to look at them?' Thereafter, an expensive red, white and blue paint was developed that would not tarnish after repeated 'heat-soaks'.

Another, perhaps more important problem for Ben and his engineers concerned the air conditioning system. The challenge was to produce a system capable of cooling down air at up to 430°C to a temperature more useful for the job. A two-stage system was devised whereby air bled from the 9th stage of the J58's compressor was led through a ram air bleed, air cooled and then fed through a fuel cooler. The result was conditioned air at -20°C, which was supplied to the cockpit and maintained regulated steady-state temperatures of between 20



◀ The nose gear bay was kept cool by the aircraft's environmental air system and no further protection was required for the nose wheel tyres. (Paul F. Crickmore)

◀ A titanium shroud was fitted inside each main gear well to help protect the undercarriage tyres from heat damage during sustained high-Mach flight. (Paul F. Crickmore)

▼ The inlet centrebody played a key role in the aircraft's propulsive system, helping regulate airflow throughout the entire flight envelope. (Lockheed Martin)

and 30°C; it was then ducted to various equipment bays and the nose wheel bay and, having reached a temperature of between 60 and 75°C, was vented overboard through exit louvres. The nose gear tyres were also cooled in this manner. A pressure differential of 1psi was maintained in the bays to ensure that flow always vented out.

As fuel was burnt off and the temperature of that remaining increased, a system of smart valves was used to direct hot fuel to the engines and cool fuel back into the tanks for environmental cooling. Thermodynamic heating dictated that fuel in the wings was used first, due to their high surface area to volume ratio. Fuel tank sequencing was automatic and centre of gravity control was provided by pumping fuel from one area to another.

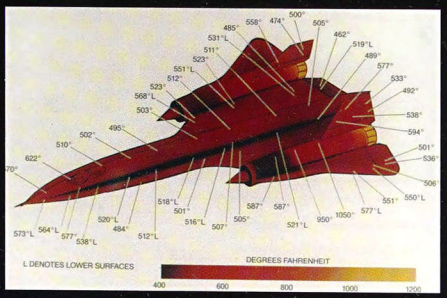
In an interview, Ben noted that an interesting side effect of fuel depletion was that differential expansion between the top of the fuselage and the cooler underside, where fuel remained, pushed the chines downwards, marginally changing their aerodynamic characteristics.

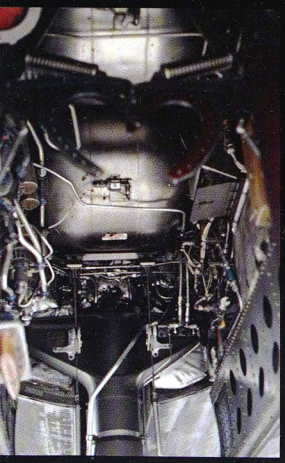
POWERPLANT

Two Pratt & Whitney JT11D-20s (J58 in US military nomenclature) powered the SR-71, each developing a maximum afterburning uninstalled thrust of 34,000lb at sea level in static condition.

Having its beginnings in a US Navy project that was subsequently cancelled, the engine retained its earlier even-numbered, Navy designation – hence an even-numbered engine (J58) was used in an Air Force airframe. The engine was designed for continuous operation at compressor inlet temperatures above 400°C. Its stretched design criteria – particularly the

▲ Inside the Burbank production facility, Article 2031 (61-7980) in the foreground is yet to be mated with the aft wing section at fuselage station (FS) 715. The outboard wing sections are also yet to be positioned. Directly behind Article 2031 is Article 2029 (61-7978). (Lockheed Martin)





▲ Thermal heating encountered at operational speeds and altitudes ruled out aluminium as the primary construction material. (Lockheed Martin)

◀ A pair of 105-litre nitrogen dewars was carried in the nose gear bay to pressurize the fuel system and purge the tanks of vapour as fuel was burnt off. (Paul F. Crickmore

high Mach number and associated large air-flow turn-down ratio – led to the development of a unique variable cycle engine (later known as a bleed bypass engine), a concept conceived by Pratt & Whitney's Robert Abernathy.

To solve the problems associated with high compressor inlet temperatures (CIT), the single rotor, nine-stage, 8.8:1 pressure ratio compressor used bleed bypass at high Mach. When opened, bypass valves bled air from the fourth stage of the nine-stage compressor and six ducts routed the air around the rear stages of the compressor, combustion section, and turbine. The bled air was then reintroduced into the turbine exhaust around the front of the afterburner, where it was used to both augment thrust and cool the back end. Transition to bypass operation was scheduled by the main fuel control as a function of compressor inlet temperature and engine speed; this usually occurred within a CIT range of between 85 and 115°C and corresponded to a Mach range of between 1.8 and 2.0.

In addition to reducing the effects of high temperatures, the bleed bypass process also sharply reduced airflow pressures across the rear stages of the compressor assembly, preventing them from choking with high-velocity airflow; it also prevented the front stages from stalling due to low-mass airflow. To further minimize the possibility of stalling the front stages of the rotor blades at low engine speeds, the engine incorporated movable inlet guide vanes (IGVs) to help guide airflow to the compressor. During take-off and acceleration to intermediate supersonic speeds, these remained in the 'axial' position in order to optimize air ingestion to the compressor. A change to the 'cambered' position occurred at the same CIT values as those set to activate operation of the bleed bypass process in order to ensure that the CIT remained within limits; the compressor temperature had a maximum limitation of 427°C. Failure of the IGVs to transition to the 'cambered' position was a mandatory abort item on the 'Go, No-Go' checklist.

The engine contained a two-stage turbine, discharge temperatures from which were monitored by exhaust gas temperature (EGT) sensors. At cruising speeds the EGT rose to 1,100°C. This presented Pratt & Whitney with one of its greatest challenges, one that was eventually overcome by Joseph Moore, a materials engineer at the Florida Research and Development Center, who perfected Astralloy, a special high-temperature alloy used in the first and second stages of the J58's turbine.

The main and reduction gearboxes were mounted

◀ Five SR-71s at various stages of completion; the aircraft in the foreground is probably Article 2001 (61-7950), the prototype. Note the titanium tail, which was later changed for composite units similar to those equipping the third aircraft from the camera. Note the various shapes of RAM (in black) used to reduce the aircraft's RCS. (Lockheed Martin)

beneath the diffuser section of each engine and were mechanically linked to its compressor section. The main gearbox was connected to an external drive shaft for starting the engine, while the reduction gearbox provided mechanical power to the airframe-mounted accessory drive system (ADS), which included a constant-speed drive linked to a 60KVA electrical generator, two hydraulic pumps and a fuel circulating pump.

FUEL

The major components of the engine fuel system comprised the engine-driven fuel pump, main fuel control, windmill bypass valve and variable-area fuel nozzles in the main burner section. The two-stage engine-driven main fuel pump consisted of a single centrifugal pump that acted as a boost stage, and its second stage, made up of two parallel gear-type pumps with discharge check valves; this configuration facilitated continued operation if either pump failed.

The main fuel control metered main burner fuel flow and controlled the bleed bypass, start bleed valves, IGVs and exhaust nozzle modulation. It regulated engine thrust as a function of throttle position, compressor inlet air temperature, main burner pressure and engine speed.

Afterburner operation was always at military-rated engine speed and EGT, and the control had a remote trimmer for EGT regulation. The pilot set these one engine at a time during EGT trim checks prior to take-off to ensure that the temperature remained within limits. The engine was equipped with an eight-unit can-annular combustion section with 48 variable-area, dual-orifice fuel nozzles, arranged in clusters of six nozzles per burner.

The extremely high airframe temperatures encountered by the SR-71 during high-Mach cruise ruled out the use of JP-4 fuel, since it would have ignited in the aircraft's 'wet' tanks. Instead, bespoke JP-7 (known as PWA 535 or PWA 523E in the *Flight Manual*) was used, also containing a lubricant to aid fuel pump operation. It was developed by Pratt & Whitney in partnership with Ashland, Shell and Monsanto and remained stable despite the high-temperature environment.

▲ Access to the J58 was via an ingenious hinge arrangement along the top of the engine nacelle. (Paul F. Crickmore)

The fuel was used as a hydraulic fluid to activate the main and afterburner fuel nozzles before being injected into the fuel burners at more than 350°C and 130psi. Such high fuel burn temperatures presented the design team with another problem, as standard electrical plugs were incapable of igniting it. This was overcome by developing a unique chemical ignition system (CIS) using tri-ethyl borane, which is extremely flash-sensitive when oxidised.

A small TEB tank was carried and the fluid used to start or restart the engines and afterburners on the ground or in the air. To ensure that the system remained inert when not in operation, gaseous nitrogen was used to pressurize the TEB tank and power the piston that injected it into the burner cans during the ignition process, regardless of engine operating conditions.

As fuel was burnt, gaseous nitrogen was also used to pressurize the fuel tanks to prevent them from being crushed as the aircraft descended to lower levels to either air refuel or land. Liquid nitrogen was carried aloft in three dewars in the nose gear well. Each time the SR-71 air refuelled, the nitrogen gas in the fuel cells was vented overboard and range was therefore governed by the number of times the aircraft could be refuelled before its liquid nitrogen supply became depleted.

Development of a durable fuel tank sealant was an ongoing problem. Cruising at high Mach, it has been estimated that the aircraft expanded 3in. in length due to thermodynamic heating. Upon descending to air refuel, the airframe cooled, a process that was considerably speeded up as fuel at -50°C was pumped into the tanks from a KC-135 or KC-10 tanker at 5,000lb per minute. This cycle of events was repeated up to six times during an extended

mission and many more times in the period between major overhauls. The pounding taken by the silicon-based sealant invariably led to it cracking, causing fuel to leak from numerous gaps.

This phenomenon was especially apparent when the aircraft was fully fuelled, because most of the leaks appeared on the topside of the tanks, which became hotter and drier during high-Mach flight. As a consequence, it was necessary to perform routine resealing and extensive depot-level fuel tank maintenance when an SR-71 was returned to Palmdale (the old sealant was usually stripped away and replaced). It was a problem that remained with the aircraft throughout its operational life.

OIL SUPPLY SYSTEM

The engine and speed-reduction gearbox were lubricated by an engine-contained 'hot tank' closed system. Its oil was cooled by circulation through an engine fuel-oil cooler, the tank being mounted on the lower side of the engine compressor case tank; its capacity was 6.7US gals. The oil was gravity-fed to the main oil pump and forced through a filter and the fuel-oil cooler; from there it was distributed to the engine's bearings and gears before being returned to the tank by scavenge pumps. Engine oil temperature was controlled by engine fuel that was passed through the main fuel-oil heat exchanger.

ACCESSORY DRIVE SYSTEM

An ADS was mounted forward of the engine in each nacelle. It consisted of a constant speed drive, an accessory gearbox and an all-altitude oil reservoir. Power from the engine was transmitted to the ADS via a reduction gearbox on the engine and a flexible drive shaft. The constant speed drive within the ADS converted the variable shaft speed to a constant rotational speed to power the AC generator. Two hydraulic pumps and a fuel-circulating pump were also mounted on the ADS gearbox. The two hydraulic pumps supplied power to the A and L or B and R hydraulic systems, while the fuel circulating pump supplied fuel to the aircraft heat sink system.

AIR INLET CONTROL SYSTEM

The Blackbird family boasted a unique, highly efficient air inlet/powerplant system that generated thrust via three components: an asymmetric mixed-compression, variable-geometry inlet; the J58 engine; and a convergent/divergent blow-in door ejector nozzle. The air inlet control system (AICS) regulated the massively varying internal airflow throughout the aircraft's entire flight envelope, ensuring that the engines received air at the correct velocity and pressure.

To satisfy the J58's voluminous appetite for air at ground idle, taxiing and take-off, the centrebody spikes were positioned fully forward, allowing an uninterrupted flow to the engine compressor. Supplementary flow was provided through six forward bypass doors, and a reverse flow was set up through exit louvres on the spike's centrebody and a set of variable-area 'inlet-ports' that were regulated by an external slotted band, which drew air in from two sets of doors. The task of operating these doors was initially manually controlled by the pilot, but later accomplished automatically by a digital automatic flight inlet control system (DAFICS)

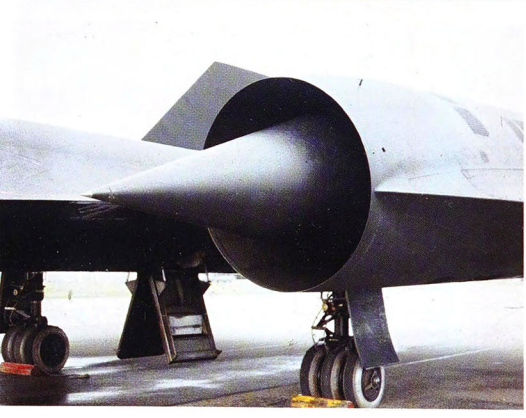
computer. The DAFICS also controlled the position of the electrically operated, hydraulically-actuated spike.

Operating together, the forward bypass doors and centrebody spike controlled the position of the normal shockwave, just aft of the inlet throat. To optimize inlet efficiencies, the shock wave was captured and held inside the converging/diverging nozzle just behind the narrowest part of the 'throat', thereby achieving the maximum possible pressure rise across the normal shock.

▼ The inlet spike regulated the volume of air entering the inlet by moving backwards from the position seen here as the aircraft's speed increased. (Paul F. Crickmore)

Once airborne, the forward bypass doors closed automatically as the undercarriage retracted. At Mach 1.4 the doors began to modulate, again automatically, to obtain a pre-programmed ratio between dynamic pressure at the inlet cowl on one side of the throat and static duct pressure on the other side. Upon reaching 30,000ft, the inlet spike unlocked and at Mach 1.6 began a rearward translation, achieving its fully aft position of 26in. at Mach 3.2, the inlet's most efficient speed. As the spike moved aft, the 'capture airstream tube area' increased by 112 per cent, while the throat restriction decreased by 46 per cent of its former size.

A peripheral 'shock trap' bleed slot (positioned around the outer circumference of the duct, just forward of the throat and set at twice the boundary layer displacement thickness) shaved off 7 per cent of the stagnant inlet airflow and stabilized the terminal (normal) shock. It was then rammed across the bypass plenum through 32 shock trap tubes spaced at regular intervals around the circumference of the shock trap. As this compressed, tertiary air travelled down the secondary bypass passage; it firmly closed the suck-in doors and cooled the exterior of the engine casing before being exhausted through the ejector nozzle. Potentially turbulent boundary layer air was removed from the surface of the centrebody spike at the point of its maximum diameter and then ducted through the spike's hollow support struts before being dumped overboard through nacelle exit louvres. The aft bypass doors were opened at mid-Mach to minimize the aerodynamic drag that resulted from dumping air overboard through the forward bypass doors.



▲ Here the inlet spike is in the fully aft position. (Paul F. Crickmore)

By carefully dovetailing the above systems, the inlet was made capable of generating internal duct pressures of 18psi. Considered against the ambient air pressure at 82,000ft of just 0.4psi it is immediately apparent that this extremely large pressure gradient produced a similarly large forward thrust vector. In fact, at Mach cruise, it accounted for no less than 54 per cent of the total thrust produced; a further 29 per cent was produced by the ejector, while the remaining 17 per cent was generated by the J58 engine.

But airflow disturbances could disrupt this delicate pressure-balancing act with a dramatic result – the unstart. These aerodynamic disruptions occurred when the normal shock wave was 'belched' forward from the inlet throat, causing an instant drop in inlet pressure and thrust. With each engine positioned at mid-semi span, the shock wave departure manifested

itself in a vicious yaw in the direction of the unstarted engine; sometimes these were so strong that crew helmets knocked against the cockpit canopy framing.

On the SR-71, recovery from involved an automatic computer-sequenced inlet restart. This involved the spike being driven forwards and the forward bypass doors opening to recapture and reposition the shock wave. The spike then returned to its correct position, followed by the bypass doors, which reconfigured the inlet to its optimum performance. Unstarts were a regular feature of early SR-71 flights, but as computer software improved the DAFICS was able to achieve near-perfect inlet airflow control and practically rid the jet of its unstart problems.

To improve the duct's diffusion rate, small rounded protuberances, referred to by the design team as 'mice', were positioned at the rear of the duct. Acting like vortex generators, they changed the area of distribution and thereby improved recovery. Early in the programme, Lockheed engineers also rechristened other assemblies – the free-floating trailing edge flaps at the end of the nacelles, used to help shape the exhaust plume, were referred to as 'tail-feathers'. Perhaps a little less obvious were the terms 'onion slicer', used to describe the forward bypass system, and 'cabbage slicer', for the aft bypass system. A memo later issued from upon high instructed that henceforth correct terminology would be used at all times.

▼ Note the shock diamonds in the exhaust plume of this J58 undergoing tests on a static rig. Shock diamonds form in a supersonic exhaust plume if the exit nozzle is slightly over-expanded, causing the gases' static pressure to be less than the ambient air pressure. The resulting pressure rise substantially increases the gases' static temperature, causing reignition of unburnt fuel vapour in the exhaust plume. (Lockheed Martin)

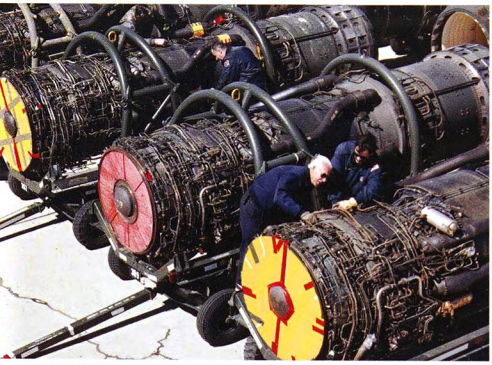
FUEL SYSTEM

The SR-71 had five individual fuselage tanks, numbered 1A, 1, 2, 4, and 5, and two wing-fuselage tank groups numbered 3 and 6 (tank 6 was further divided into 6A and 6B). Interconnecting plumbing and electrically-driven boost pumps were used for fuel feed, transfer and dumping. The fuel system moved the aircraft's centre of gravity by automatic tank sequencing to the engine feed manifolds or manual aft transfer into tank 5 when it was less than full, or manual forward transfer into tank 1.

Tank capacities were:

Tank	Fuel capacity (US gals)	Fuel weight (lb)
1A	251.1	1,650
1	2,095.9	13,770
2	1,974.1	12,970
3	2,459.7	16,160
4	1,453.6	9,550
5	1,758.0	11,550
6A (forward)	1,158.3	7,610
6B (Aft)	1,068.5	7,020
Total	12,219.2	80,280

Sixteen single-stage, centrifugal, AC-powered boost pumps supplied fuel to the manifolds. Tanks 1 and 4, which normally fed fuel to both engines, were each equipped with four pumps, while tanks 2, 3, 5 and 6 each had two pumps. Where the pumps were grouped in pairs, either pump was capable of supplying fuel at sufficient pressure to permit engine operation at reduced afterburning thrust if the other failed.



▲ By the time General Larry Welch cancelled the SR-71 programme on 22 November 1989, enough engines and spares had been stockpiled to keep the fleet running well into the 21st century. (Lockheed Martin)

ELECTRICAL SYSTEM

Electrical power was normally supplied by two AC generators, each rated at 60KVA. They were mechanically driven by their respective engines through constant speed drive (CSD) units and operated in parallel. They provided 115/200V, 400-cycle, three-phase power to five AC buses and two 200A transformer-rectifiers, which energized three 28V DC buses. Either generator was capable of supplying the normal AC and DC power requirements of the aircraft.

Two 25A/hr batteries provided limited emergency power if both generators were off or inoperative, or if both transformer-rectifiers failed; each battery individually supplied one of the two essential DC buses. The maximum duration of the dual-battery power system was about 40 minutes, provided that all unnecessary electrical equipment was turned off.

Heat was also responsible for electrical systems problems, especially in the high-output generators. Heat-related generator failures caused many air aborts during the first two years of SR-71 training and Category III testing. After the loss of SR-71B '957 to a double generator failure on 11 January 1968, a single generator failure was flagged as a mandatory abort item that meant 'land as soon as possible'. Over the next year, SR-71s with generator failures landed at bases across the US. Various modifications were tried before the problem was finally isolated and solved by a simple change of solder.

HYDRAULIC SYSTEMS

The SR-71 had four separate hydraulic systems, each provided with its own pressurization reservoir and engine-driven pump. Pumps for the A and L system were driven from the left engine ADS; the B and R pumps were powered by the right engine ADS. The A and B hydraulic systems powered the flight controls.

The L hydraulic system powered the left engine air inlet system, the landing gear, brakes, air refuelling door and receptacle, and the nose-wheel steering. The R system powered the right engine air inlet system; if pressure in the L system dropped to less than 2,200psi, the R system automatically powered the landing gear retraction cycle.

STABILITY AUGMENTATION SYSTEM

The SR-71's CG was automatically moved aft during acceleration to high-Mach flight to reduce trim drag and improve elevon authority in both the pitch and roll axis. The fuselage chine produced lift forward of the CG, which had the effect of destabilizing the aircraft in the pitch axis and reduced aft CG travel, resulting in low static margins of stability and safety. Additionally, the chine had an adverse aerodynamic effect on the aircraft when performing sideslip manoeuvres at cruise angles of attack (AoA) (approximately 6° of positive Alpha (AoA)). This, coupled with the low aerodynamic damping inherent to flight at high altitudes, left the SR-71 only marginally stable in pitch and yaw at high Mach.

Control in this delicate, critical corner of the flight envelope was achieved by the aircraft's elevons and all-moving fins, working through an automatic flight control system (AFCS) controlled by the DAFICS computers. The AFCS consisted of three subsystems, a stability augmentation system (SAS), autopilot and Mach trim system. As coordinating system, the AFCS provided pitch, roll and yaw stabilization via the control surfaces. Eight rate-sensing gyros detected divergence from stable flight and, together with three lateral accelerometers, also provided motion-sensing signals that were applied to the multi-redundant SAS circuits in the DAFICS. Control over the AFCS was provided to the pilot via 'Pitch SAS', 'Roll SAS' and 'Yaw SAS' switches located on the right console panel. In addition to responding to the signals from DAFICS, the servos could also be activated by direct stick and rudder pedal inputs.

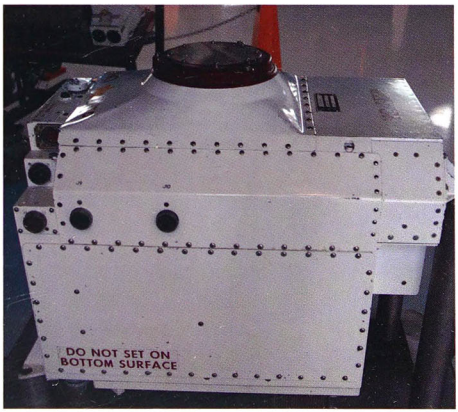
▲ The heavy cockpit canopy was reminiscent of those used on the F-102 and F-106. (Paul F. Crickmore)

The Mach trim system provided speed stability up to Mach 1.5 or below that speed, depending on whether the aircraft was accelerating or decelerating – a period during which the autopilot could not be engaged. It compensated via the pitch trim actuator for the aircraft's propensity to 'tuck' nose down while accelerating through the Mach, and rise nose up while decelerating.

ASTRO INERTIAL NAVIGATION SYSTEM

The SR-71's reconnaissance-gathering missions took it to some of the most politically sensitive areas of the world. It was therefore essential that it should be equipped with the most accurate navigation system available, particularly bearing in mind that it would be flying at a velocity of 3,000ft per second. The Nortronics Division Astro Inertial Navigation System, used in the Skybolt air-to-surface missile, was modified for use in the SR-71 and designated as the NAS-14V2.

Producing a terminal error accuracy of less than half a mile after covering distances the equivalent of more than halfway around the world, it was justifiably considered by some to be the most outstanding piece of equipment to come out of the entire Senior Crown programme. The ANS combined data from an inertial platform with a time datum supplied from a chronometer accurate to within 5ms. Position updating was achieved automatically by astro-tracking six of the 52 most prominently visible stars at any time by day or night. The stars were computer catalogued in an ephemeris memory that could be continuously crosschecked for track position referencing. Scanning the celestial bodies sequentially, through a pre-programmed tracker mechanism mounted on a gimballed platform on top of the nav unit, the astro-tracker provided passive, refined location information.



▼ The Nortronics Division ANS updated the SR-71's inertial navigation system automatically by constantly astro-tracking six of the 52 most prominently visible stars. (Stewart Bailey)

When the autopilot was coupled to the ANS through the auto nav function switch, the aircraft could be flown automatically and precisely on a predetermined flight path. The preplanned route (worked out by highly experienced navigators) was electronically loaded via a Milar tape into the ANS's computer memory a few hours prior to take off. Inflight modifications could be made by the RSO using his control and display panel. During flight, the computer-sequenced plan directed the aircraft from one destination point (DP) to the next.

Two further features of the ANS included ground reference position updating through the forward-looking view sight, and sensor monitoring by reference to control point (CP) actions; CPs were pre-determined track points, programmed into the ANS, that would activate or deactivate reconnaissance sensors and served to alert the RSO that the system was about to turn on, that the system had functioned correctly, and that programmed activities were being automatically carried out.

The ANS was backed up by a Singer-Kearfott SKN-2417 INS with a circular error probable (CEP) of 1nm per hour. This replaced the SR-71 gyro flight reference system (FRS) in June 1982. The earlier system had no navigation capability and provided heading and attitude information only.

At the heart of the new unit was an inertially-stabilized platform (four gimbals for all-attitude operation, vertical and azimuth gyros and three sub-miniature pendulous linear accelerometers). Located in the so-called R-bay, the gyro-platform provided navigation data to a control panel located in the RSO's cockpit.

MISSION RECORDER SYSTEM

The mission recorder system (MRS) was an airborne mission and maintenance data-recording system used to store up to 12 hours of monitored aircraft and system performance information. In addition, the MRS recorded the actions of the reconnaissance sensors and navigation systems, as well as all inter-cockpit and radio voice transmissions.

The purpose of this crash-survivable system was to identify failures, impending failures, and sub-standard system performances for maintenance purposes or accident analysis. Data collection was achieved through multiplexing switches within the MRS, which sequentially shared analogue and digitized signals at a sample rate of once every 3 seconds. Once activated, the system operated continuously and automatically.

After a mission, the recorded data was copied from the ACR-500 recorder-assembly on the aircraft using a Mobile Ground Formatter Unit (MGFU), which created a computer-compatible tape (CCT) of non-voice data. A portable tape copy unit (TCU) was used with the MGFU to copy the crew's voice audio recording. The table (bottom left) summarizes the number of signals monitored by the MRS within each aircraft system.

Engine	16
Hydraulic system	13
DAFICS	58
Electrical system	24
MRS	18
ANS	100
ECS	16
Miscellaneous	20

VELOCITY/HEIGHT, VELOCITY/RADIAL SYSTEM

The Velocity/Height (V/H) ratio, or Forward Motion Compensation (FMC) system, produced signals scaled electrically through the V/H bus to represent the angular rate of motion between the aircraft and terrain below. Signal sources for the system were the ANS and the V/H indicator in the RSO's cockpit. These signals were scaled at 0.2V (DC) per milliradian per second (mil/s), and caused the reconnaissance camera's mirror or film platen to move in such a way that the target image remained stationary relative to the aircraft (and therefore sharp), during film exposure.

The Velocity/Radial (V/R) distance was also used to drive the camera's motion compensation mechanism, based upon the actual distance between the aircraft and its target. For example, when the SR-71's Technical Objective Cameras (TEOCs) were looking out at an angle of 45°, their slant range was significantly greater than the aircraft's altitude and therefore required an element of FMC. The required FMC was calculated by dividing the aircraft's altitude by its true airspeed. For example, at 77,500ft and 1,850kt true airspeed (KTAS), V/H = 42mil/sec.

The Sensor Event/Frame Count system also aided surveillance interpretation. It correlated time, position, altitude and heading while the TEOCs were in operation, using the ANS mission recorder system and a signal sensor processor to convert event input signals into 6ms-wide event marker pulses that were monitored by the ANS. On receiving an even marker pulse, the ANS activated a frame-count register associated with a particular sensor. This data (with precise location information) was recorded by the mission recorder system.

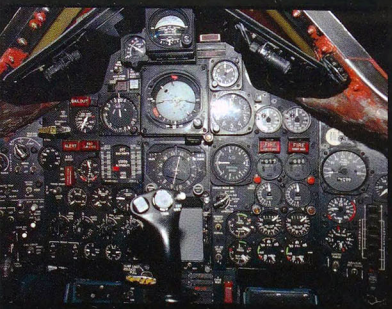
▲ Although the A-12 was highly advanced, its cockpit instrumentation was conventional. The hooded view scope can be seen at the top of the picture. (Roadrunners Internationale)

The RSO could manually operate and control all reconnaissance sensors, but in practice these were normally fully preprogrammed for automatic turn-on/turn-off and changing 'look angles' in order to frame hundreds of separate targets of interest. A manual exposure control panel enabled the RSO to remotely control camera exposure to take account of lighting conditions (brightness and reflectivity). This was graduated in degrees of sun angle, with reference indices for low, normal, high and very high terrain reflectivity. Such changes were made by regulating DC voltage between 10 and 38V for sun angle settings between 5 and 90°.

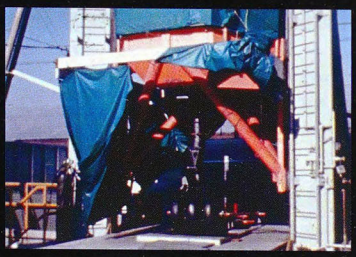
COMMS AND NAV EQUIPMENT

The SR-71's communications and avionics equipment comprised an AN/AIC-18 interphone system for crew inter-communication and crew-to-groundcrew interphone communication. A COMNAV-50 UHF radio provided voice transmission and reception on any of 7,000 channels in the P-band frequency range, and a direction-finding capability. The system operated in two modes: 'internal', which was compatible with other types of UHF radio, or 'external', wherein coded communication was possible only with other COMNAV-50 radios.

Operating in the 'external' mode the system offered high resistance to jamming, in addition to security and a range-measuring capability. Two independent UHF radio sets were provided, designated UHF-1 in the front cockpit and UHF-2 in the rear cockpit. A modem control panel in the RSO's cockpit controlled the coding of 'external' signals and discrete selection of the ranging partner. An AN/ARA-48 automatic direction finding (ADF) antenna was used in conjunction with the UHF radio system, automatically pointing to emissions emanating from compatible equipment transmitting on the same frequency, so that with the radio operating in 'external' mode, the ADF function would operate provided that it was within the detection range of a similarly programmed COMNAV-50. The system had a range of up to 200nm.

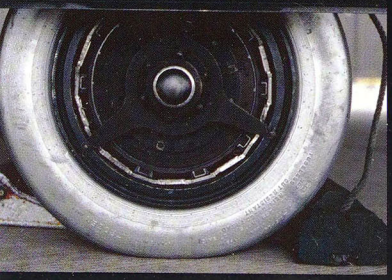


▲ The SR-71's front cockpit betrays its 1960s' vintage. (Paul F. Crickmore)



▲ A main undercarriage undergoes drop tests. The unit featured a hollow-axle arrangement that enabled any wheel to be changed without removing the other two. (Lockheed Martin)

▼ The 32-ply main tyres were made by B. F. Goodrich and filled with inert nitrogen gas to a pressure of 415psi. Their walls were impregnated with aluminium powder to reflect heat while they lay retracted in the wheel well. They were good for 15 full-stop landings and cost $2,300 each. (Paul F. Crickmore)



An AN/ARC-186(V) VHF radio provided AM transmissions and reception from 108.000 to 151.975MHz. Frequency spacing was 25KHz and 20 channels could be preset in addition to the emergency 'guard' frequency (121.5MHz). Either narrow or wideband operation was possible, but this had to be preset by maintenance personnel. The FM capability of the radio was not operative.

For long-range voice communication, the SR-71 was equipped with 618-T and AN/ARC-190C(V) HF radios. The modes of operation for the 618-T were single sideband (SSB) or amplitude modulation (AM). The frequency range was 2 to 30MHz, tunable in 1KHz steps. The ARC-190 received and transmitted on 280,000 frequencies in a band from 2 to 29.9999MHz, spaced at 100Hz. Modes of operation were upper and lower sideband, AM and continuous wave; the aircraft's pitot boom was the antenna for both HF radios.

A 51RV-1 ILS receiver supplied signals to the bank and pitch steering bars, the glideslope indicator on the attitude director indicator (ADI) and to the course deviation indicator (CDI) on the pilot's horizontal situation indicator (HIS), enabling him to conduct instrument landings. The receiver operated on 20 frequencies; localizer frequencies ranged from 108.1 to 111.9MHz, while glideslope frequencies ranged from 329.3 to 335.0MHz. The correct glideslope frequency was automatically tuned when the localizer frequency was selected.

The SR-71 was equipped with two IFF transponders, an AN/APX-108(V) (W/SB R-2668) and a WILCOX 914X-2 IFF (W/O SB R-2668). The system included altitude reporting (suppressed by the RSO above 60,000ft), selective identification and emergency reporting features. Mode 4 provided an encrypted IFF capability. Two beacons, a G-band and an I-band, were provided to aid radar tracking when the SR-71 was participating in special tests.

Finally, for non-covert flights the aircraft was equipped with an AN/ARN-118(V) TACAN, used with ground stations and cooperating aircraft.

SENSOR SYSTEMS

The first operational SR-71 mission, flown under the code name Giant Scale, was performed from Kadena by Maj Jerry O'Malley and his Reconnaissance Systems Officer (RSO) Maj Ed Payne in aircraft '976, on 21 March 1968. For this historic sortie, the aircraft was configured with a high-resolution radar (HRR) in its nose section.

Code named PIP (Product Improved Radar) by the Air Force, it had been developed and built in 'the black' by Goodyear Aerospace, which designated it 531 or GA-531, the numbers signifying the block number it assigned to identify the SR-71's drawings. The antenna received X-brand Doppler phase information, which was stored on a recorder housed in the forward right mission bay. This was then transferred onto a continuous 4in-wide map film via a ground-based

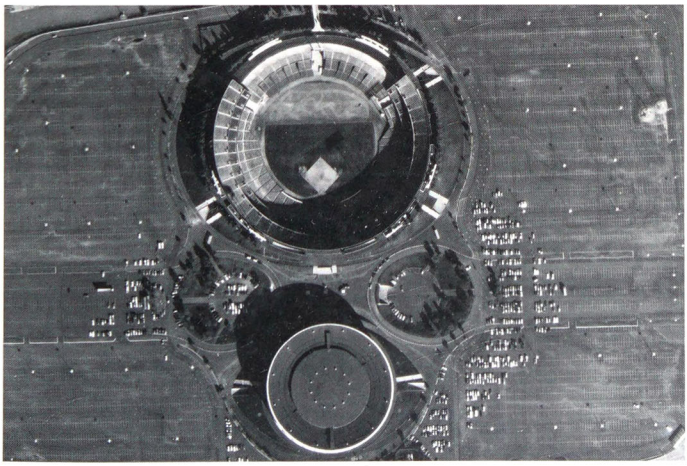
optical correlater; the end result was an image similar in appearance to that obtained by a camera with a ground resolution of about 10ft.

A Fairchild Camera Company F489 terrain objective camera (TROC) was installed in the SR-71's so-called C-bay. Equipped with a 6in. focal length lens, this wide-angle mapping camera operated throughout the sortie, producing a single overlapping exposure of the terrain directly below; its 663ft of film, weighing 135lb, could photograph a strip 7,800nm long at 55 per cent overlap. The developed images enabled photo interpreters to cross-check the aircraft's position and provide additional ground cues in relation to targets photographed by the other sensors.

Bays P and Q held close-look Hycon HR-308B variable pointing angle, high-resolution, narrow-field framing technical objective cameras (TEOCs), also known as Tech cameras. They were mounted horizontally but a tilting beryllium mirror in the camera's scan-head enabled viewing of targets below and out to about 45°. The camera touted a 48in. focal length lens that imaged onto fine grain film producing a 9½in-square frame; maximum film capacity was 1,500ft, producing 1,800 usable frames per camera per flight and track coverage of about 2,000nm, the nominal ground area photographed was about 2½ miles square.

The TEOCs had four modes of operation. Burst mode took a burst of 10 photographs at a rate of about one per second. Stepping mode slewed the camera head back and forth, four digits either side of a commanded look angle, to provide wider coverage of a given area when a target's precise location was unclear or the area of interest was wider than the normal frame width. Two overlap modes were also available: one was timed to provide a 55 per cent overlap of each consecutive frame, the other produced a 10 per cent overlap between frames.

▲ An SR-71's Hycon HR-308B technical objective camera. Note the beryllium mirror in the scan head, which was angled to photograph targets relative to the aircraft's position. (Stewart Bailey)



◀ A baseball ground photographed from 80,000ft by an SR-71's optical bar camera during a stateside training mission. Note the easily discernible 4in. wide white lines delineating car parking spaces. (USAF)

The system was activated automatically by the ANS or manually by the RSO. The camera was available in two models: HR-308B and HR-308C. The B model had two versions, the -11 and -21. Except for passive vibration isolation, the HR-308B was unstabilized, while the HR-308C was actively stabilized in pitch, roll and, at higher look angles, yaw.

On that historic, first operational mission, aircraft '976 also carried two Itek Corporation HR-9085 operational objective cameras (OOCs). These were also mounted horizontally and used a mirrored scan head; they were located in bays S and T. These high-resolution, three-dimensional panoramic cameras had a focal length of 13in. and a maximum capacity of 3,300ft of 70mm film, sufficient to cover 3,600 frames, with alternate forward and aft exposures of the terrain below and to the side of the aircraft's track. Each camera had a lateral coverage of 45° and total track coverage of about 1,500nm; they were manually activated by the RSO.

HRB-Singer produced the little-known HRB-454 IR sensor system for the Senior Crown programme, recording out to 45° either side of the aircraft's flight path on 100ft of 70mm film. Having undertaken its first SR-71 Cat II flight test on 3 May 1966, it completed 49 IR test flights, but was discarded early in the aircraft's operational career.

At 14:00hrs on 5 April 1972, Randy Hertzog and his RSO John Carnochan launched '980 from Kadena equipped with an optical bar camera (OBC) in the nose section for the system's first operational test. This panoramic camera was fitted initially with a 24in. focal length lens (in November 1973, SAC received its first OBC unit fitted with a 30in. lens). It was built by the Itek Corporation and obtained high quality horizon-to-horizon imagery focused on fine-grain black and white film with an ISO rating of just 8.

So successful were the results that by the end of the year the Strategic Reconnaissance Center (SRC) directed that the OBC be used whenever weather over South-East Asia permitted and that on days of heavy cloud cover the HHR unit should be substituted, an operation that took maintenance about 16 hours to complete. Having proved its worth, the OBC went on to replace the OOC as a means of collecting panoramic coverage.

The OBC was contained inside a shroud mounted on a hatch. An extension of the cold air supply in the forward chine bay directed refrigerated air into the shroud above and on each side of the rotating lens system; warmed air exhausted into the nose compartment. To prevent the OBC lens system from being over-cooled, electric heaters in the shroud ensured that the temperature was maintained at approximately 40°C.

The film was supported by air was ducted through the canopy seal supply line, and although the camera wasn't stabilized, it was equipped with vibration isolation and a damping system compatible with its environment in the nose. The lens system had a fixed aperture and was mounted on an 'optical bar' that accommodated the lens and two mirror assemblies used to create the folded optical path.

In operation the optical bar rotated continuously around its longitudinal axis. Film exposure was accomplished via a scanning slit shutter while the bar and film were in motion. The width of the slit adjusted automatically to compensate for varying degrees of brightness and the velocity/height (V/H) ratio. Full coverage was obtained through a scan angle of 140°, ie 70° either side of the aircraft's track, with a field angle along the flight path of approximately 8°. Aircraft FMC was provided during frame exposure when the V/H ratio was between 35 and 45mil/s; otherwise the FMC was automatically set at 40mil/s if the applied signal fell outside that range.

A data block in each frame recorded mission information, frame number and camera fore/aft or vertical orientation. The camera's cycle rate was controlled automatically by the frame overlap requirement of each of the three available modes of operation and by the V/H FMC. The film used was either 3414 or 1414 and the operating mode could be selected in flight.

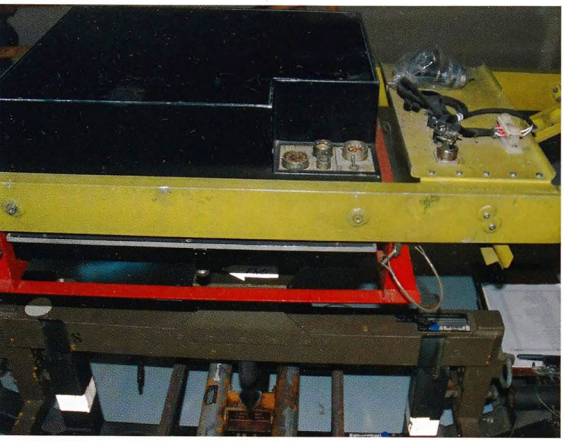
▲ Removed panels on the underside of this SR-71's nose reveal the antenna for the CAPRE high-resolution ground-mapping radar. (Lockheed Martin)

The final major sensor upgrade intended to become operational on the SR-71 prior to the end of the war in South-East Asia was the Capability Reconnaissance Radar (CAPRE), an improved HRR designed to replace the PIP. Manufactured by Goodyear Aerospace Corporation, the prototype received its baptism of fire in '975, flown by Maj Bob Cunningham and RSO Maj George Morgan on 12 August 1972. However, due to various technical problems, the anticipated deployment of production units on the three SR-71s participating in the June 1973 deployment to Kadena was delayed and PIP units were again used.

The CAPRE system was a synthetic aperture side-looking airborne radar (SLAR) and could be used in conjunction with the Radar Correlator Display (RCD) to produce an inflight display for navigation purposes. Its main function, however, was to illuminate ground targets that were then recorded onto a film strip on two recorders housed in the aft portion of the right forward mission bay, or L-bay. Range marks and data block information were automatically superimposed onto the film and the unit could be programmed to cover a strip either 10 or 20nm wide to either side of the aircraft's track, with the near edge of the swathe between 10 and 70nm from the aircraft.

CAPRE could only be used in straight and level flight. Two modes of operation were provided: in automatic, system operation was controlled by the ANS and in manual the RSO was in control.

The RCD was a self-contained unit located in the forward portion of the aft cockpit. It operated in conjunction with, but was independent from, the radar recorders. The RCD operated when the SLAR was in operation, since it depended on SLAR Doppler phase history video to produce the inflight display for navigation. The display moved downwards at a rate proportional to the aircraft's ground speed and was normally 50s (25nm at cruise speed and altitude) behind the aircraft's real-time position. The RCD map display was 15nm wide and



▲ The Ampex Model AR-1700 recorded a wide range of ELINT signals, from locations up to 350 miles from the SR-71's track, onto magnetic tape. It also recorded aircraft maintenance data. (Stewart Bailey)

had to be stopped by the RSO for target evaluation and the determination of navigation fix-point error.

The final radar system developed and deployed on the SR-71 fleet before programme shutdown was the Loral Advanced Synthetic Aperture Radar System (ASARS), which catapulted radar-generated ground mapping into a new dimension. First deployed operationally to RAF Mildenhall on 9 July 1983, it is believed that the system had a resolution of less than 12in. at nadir from 80,000ft. As a note of interest, all three ground-mapping radars built for the SR-71 emanated from the same production facility.

Its ownership changed several times over the years; the first system was built by Goodyear, which also built the CAPRE/HRR system, but the company was subsequently bought by Loral. Under that name, ASARS was developed and fielded. In 1996 Lockheed Martin bought Loral's imaging business, selling it to BAE Systems in 2000. Fairchild, which had also been responsible for manufacturing SR-71 camera equipment, sold its imaging portfolio to Loral in 1980 and today BAE continues in the business of high-end sensors under the resurrected Fairchild Imaging brand.

SIGINT RECEIVERS

In May 1969, the SR-71's electromagnetic reconnaissance system (EMR), built by Airborne Instrument Laboratories, was deployed for operations. The system was interfaced with the ANS and MRS for data collection and with the IFF, TACAN, SLAR and DEF systems to prevent received intelligence being masked by transmissions from those systems.

To provide meaningful data it was necessary that the ANS was fully operational even though the EMR operated independently. Once activated by the RSO, it was an entirely automatic, passive collection system and performed two search functions simultaneously, special search and general search. Special search was based upon pre-flight instructions in the ELINT Improvement Program (EIP) computer that designated emitters of special interest. When a received signal matched the designated emitter, a monitor receiver was automatically tuned to that signal for a pre-programmed period, and the signal pulses were passed to special detectors and recorded on tracks of the continuous analogue recorder as video signals to be evaluated using specialist equipment after landing.

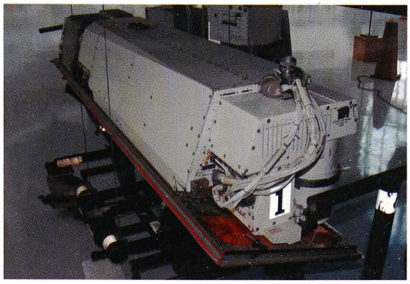
The general search function searched the frequency spectrum from 30MHz to 40GHz. This spectrum was divided into six bands, all of which were searched simultaneously. Every emitter signal received in the bands was recorded on the digital recorder by way of time, frequency, direction, pulse width and amplitude.

The continuous analogue recorder was a 14-channel Ampex Model AR-1700, a wide band magnetic tape recorder that stored special search signals, ELINT data from the on-board DEF systems and maintenance data. The recorder could be operated automatically by the EIP system and/or manually by the RSO.

The tape transport operated at 60 or 120in/s. A 14in. reel supplied 9,200ft of 1in. magnetic tape that provided 30 or 15 minutes of recording time per flight.

The increased capability provided by the EIP generated further mission requests from SAC for information required for its Single Integrated Operational Plan (SIOP) and also from the Defense Intelligence Agency (DIA), CINCPAC, Military Assistance Command Vietnam (MACV) and the Commander United States Forces Korea (COMUSKOREA).

The capability also led the Joint Chiefs of Staff (JCS) to direct SAC to execute peripheral SR-71 ELINT sorties of China, the USSR, North Korea, the Taiwan Straits and Sea of Japan, in addition to overflight missions of all high threat areas of North Vietnam. The increase in aircraft utility was such that on 18 December 1970 another SR-71 was added to the Kadena detachment, and for the next two and a half years it operated four aircraft.



◀ DEF A2C provided the SR-71 with electronic defence against airborne threats. (Stewart Bailey)

▼ DEF H was an extremely effective and powerful noise jammer. (Mike Hull)

DEF SYSTEM

The SR-71 did not carry defensive weaponry but was protected electronically. ECM technologies advance quickly, so that the SR-71's defensive electronic (DEF) systems required constant updating throughout its almost 30 years of operational service. The controls required to operate all the DEF systems were located on a single panel on the RSO's left console.

An Oxcart paper dated 26 September 1967 and declassified in 2007 provided a detailed comparison of the A-12's DEF systems with those that equipped the SR-71 at the time. Two prototype systems had been built for the SR-71 and testing was due to begin in October 1967, after which the production model was to be defined. The primary system covered frequencies in the S and C-bands, required 3–10kW of power output and used deceptive noise, false targets in the main lobe and beacon receiver jamming techniques to defeat the SA-2 and AAA threat (the latter is difficult to envisage given the aircraft's operating altitude).

Five SR-71s at Beale were due to have a piece of equipment known as CFAX installed by 18 November 1967. This was to operate in the X-band, require 1kW of power output and employ techniques to defeat the SA-3 and air intercept threat. It generated false targets, and employed angle deception and countdown techniques.

Finally, an interim fit using an APR-27 and System 13C was fitted to three Beale SR-71s at the time of the report, and three more scheduled by 18 November 1967. Both systems operated within the S and C-bands against SA-2s; the APR-27 element provided threat alarm by detecting the presence of "Fan Song" radar activity, which, if necessary, activated System 13C, which used angle deception to defeat the missile threat. System 13C was carried in place of the left TEOC or ELINT package.

Later, an arbitrary alphanumeric system was used to designate the various elements of the DEF system. In March 1969, System E became operational, followed by systems F and G in June and December 1970, respectively.

In April 1972, a Special ELINT Beacon Receiver (SEBER), known as System G, was deployed for operational testing on selected Giant Scale missions; it was designed specifically to collect the beacon transponder signals of SA-2 SAMs.

The final DEF configuration included systems A2, C2, H and M. A2 was an ECM jammer designed to protect the aircraft from airborne threats operating in the X-band frequency. It consisted of two sets of receive and transmit antennas, and a gaseous nitrogen system to pressurize the transmit waveguides. The receive antennas were located in 'blisters' on the left and right sides of the nose chine and identified the threat as coming from below the aircraft in either the left or right forward quadrants. A2's transmit antennas protruded slightly from the lower surfaces of the chines opposite the pilot's cockpit. The DEF A2 system was interfaced with the MRS, radar and EMR and, when mission requirements dictated, the received signals could be recorded for later analysis on the AR-1700.

C2 worked in both the L and UHF-band of frequencies, as it had to de-conflict with the IFF and TACAN. DEF C2 worked in conjunction with DEF H to protect the SR-71 from SAM threats. It consisted of a receiver, band antenna, band-pass filter, power relay and electrical and coaxial cables. Receipt of an L-band signal from DEF C2 generated a warning for the RSO. If a lock-on or missile launch occurred, DEF H jamming could be triggered.

Carried in bay K and weighing in 900lb, DEF H was an extremely powerful piece of kit that provided threat warning and, when required, barrage and deceptive noise-jamming protection against the SAM threat. It included a transceiver, two transmitting systems, an interface unit (IU), a data processor and an evaporative cooler. Radar signals received by a forward centreline antenna were sent to the transceiver. Signals possibly associated with the SA-2 "Guideline" and SA-3 "Goa" (E-band) were received by an aft centreline antenna and routed to the DEF H system through a band pass filter and pre-amplifier.

The IU controlled the jamming pulses generated by the transmitting systems, which were designated as low band or high band. Each band could be driven by commands from the DEF control panel. Upon receipt of signals from DEF C2, DEF H transmitted on frequencies determined by the 'LO' and/or 'HI' band selections on the RSO's DEF console. Signals received by DEF H were processed to determine their polarity (vertical or horizontal), allowing for the most effective jamming response. They could be recorded on the AR-1700 for later analysis.

DEF M was a deception repeater jammer using a technique known as range gate pull-off (RGPO) against the SA-5 "Gammon". DEF M used a single antenna located on the aircraft's underside centreline forward of the RSO's view sight, and was protected by a slightly protruding fibreglass radome. The antenna was time-shared between DEF M's receive and transmit functions. Jamming continued for five seconds after the threat was no longer present.

RANGE GATE PULL-OFF OR SIDE-STEP JAMMING

Barrage noise jamming might be considered the ECM equivalent of taking a sledgehammer to crack a nut, while RGPO is the essence of surgical finesse. Basically, when a tracking radar has detected its target, it brackets it with range gates. These essentially blank out all other signals that originate from outside the narrow 'window' the gates have created, thereby increasing the signal-to-noise level ratio. The radar then 'focuses' on a range interval of just a few hundred metres that frames the target's location, and no longer attempts to detect other

targets. This state of affairs is known as radar lock-on. But range gates can be 'hijacked', causing the radar to break lock, and this is precisely what RGPO does.

Firstly, the RGPO jammer determines the incoming radar's pulse repetition frequency. It then amplifies and re-transmits it when further pulses are received. Highlighting itself on an enemy's radar screen in this way hardly seems like a good idea, but the jammer progressively increases its power, creating in the process a much stronger return than that generated from the aircraft itself. The sensitivity of the tracking radar's receiver has to be reduced to avoid overload. As a consequence, the aircraft's actual return is immersed and vanishes below the 'noise floor'.

Now the RGPO jammer transmits a second replica after each of the 'dummy' echoes. The power of this second replica return is again increased, while the dummy is made weaker. At this point, the tracking radar locks on to the now stronger second replica return, which the RGPO jammer begins to delay by small but ever increasing amounts of time. The radar's range gates follow the dummy target, which appears to be receding. This continues until the radar's range gates have moved away from the target's true position, thereby causing the radar to track a phantom target.

Now the aircraft's actual return is blanked out entirely by the range gates and the RGPO jammer switches off, leaving the illuminating radar with nothing but noise between its range gates. The threat radar now has to revert back to search or acquisition mode, while the target has sped away. Countermeasures to RGPO are available, including switching to another PRF, which renders the jammer incapable of anticipating the timing of the next illuminating pulse. There are also other methods, as well as counter-countermeasures to these, but they fall outside the scope of this book.

▲ Blackbird crew wore full pressure suits made by the David Clark Company. The suits worn by A-12, YF-12, M-21 and early SR-71 crewmembers were designated S-901 and their outer coveralls were silver in colour. (USAF)

CREW SURVIVAL SYSTEMS

Air Force regulation 60-16 requires pressure suits to be worn when flying above 50,000ft, since entry into this abnormal environment causes physiological problems that, if left unchecked, would kill unprotected personnel in minutes. For example, during ascent, a reduction in the partial pressure of oxygen will cause hypoxia if unprotected above 25,000ft. Progressive cardio-respiratory and neurological effects trigger such symptoms as euphoria, loss of judgment and impaired memory. If unchecked, semi-consciousness and unconsciousness follow, with death four or five minutes later.

Also, above 25,000ft decompression sickness (DCS) develops due to the reduction of ambient air pressure. It is acquired with increasing rapidity and severity the higher the altitude. The condition results from the evolution of nitrogen gas bubbles from body fluids as pressure falls, (much like the bubbles generated in a carbonated drink bottle when its top is removed). Joint pain (the 'bends'), chest pain, skin-itching and neurological manifestations may develop alone or together, the latter being more serious and potentially fatal.

◀ The next derivation had white coveralls, which reduced cockpit reflections and were made from flame-resistant Nomex. (USAF)

▶ The dark-brown-coloured suits made from Fypro eradicated unwanted cockpit reflections but didn't reflect cockpit heat away from the suit. (USAF)

Gas-containing body cavities – lungs, gut, sinuses, etc – increase in volume on ascent and contract on descent. Most of the problems this generates are self-righting via the body's orifices, but gas within the small gut is not free to escape and its expansion can cause abdominal pain. To help reduce symptoms, Blackbird crews ate high protein meals prior to flight.

During descent, considerable pain can arise if pressure in the middle ear cavities and sinuses cannot be equalized; for this reason crews underwent routine medicals prior to flight and should a slight cold or throat infection be detected they were grounded until the condition had cleared.

Were the crew subjected to the outside air temperature prevailing at 80,000ft, they would undoubtedly have risked local or general cold injury (frostbite or hypothermia, respectively). To protect from these effects the cockpit was pressurized and pressure suits worn. Within the cockpit, pressurization was allowed to rise from sea level to 8,000ft; it then remained constant to 25,000ft. Between these altitudes the ambient air pressure falls from 10.9psi to 5.9psi, giving rise to a pressure differential of 5psi. This maximum figure was maintained by the aircraft's pressurization system throughout the flight profile, ensuring the fuselage was not subjected to unduly high pressure gradients, which enabled structural weight to be reduced. However, in the event of rapid decompression or ejection, it meant that the crew had to wear full pressure suits to survive.

Like most other systems associated with the SR-71, the pressure suit evolved through the life of the programme. The first suit was ordered on 7 March 1960 and custom made by the David Clark Company in Worcester, Massachusetts. Designated S-901, it was made for Capt Harry Collins, who thoroughly tested it in numerous decompression checks. The second suit was ordered on 28 June 1962. Designated S-901A, it was made for Lou Schalk, the Lockheed A-12 chief test pilot. Thereafter the suits were developed in parallel with the Oxcart programme, each tailor-made for its owner and sequentially designated S-901A to S-901H. A culmination of redesign work and development created the S-970 suit, which again was bespoke for its owner and used by Agency Oxcart pilots and Air Force YF-12 crew.

The first suits designed for the SR-71 programme were designated S-901J. These varied from their forebears since they were available in 12 standard sizes, rather than custom built; the first was produced in 1965. Initially the outer coveralls of these early suits had a layer of aluminum vacuum deposited onto HT-1 material to provide a level of fire-resistance during high-Mach ejection and to help reflect heat away from the wearer in the cockpit, since the inner surfaces of the windows routinely reached 120°C.

◀ The final version of the suit used during the Senior Crown programme was the David Clark S-1030 series. (Paul F. Crickmore)

◀ The Blackbirds were equipped with a Lockheed SR-1 ejection seat, which was air tested from an F-102 Delta Dagger. (Lockheed Martin)

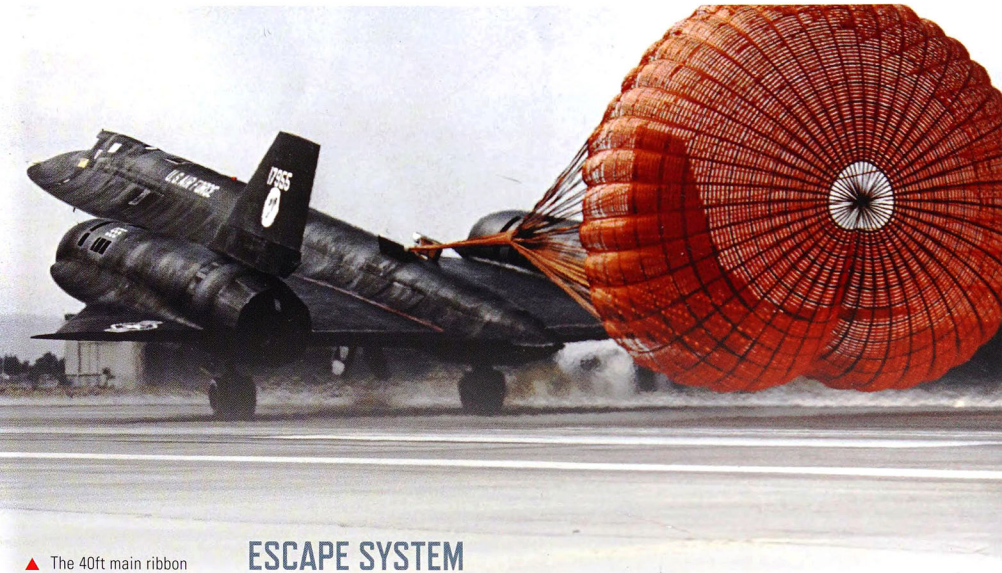
But the suit generated distracting reflections, making it difficult for the crew to monitor instruments. A white coverall in flame-resistant Nomex was therefore developed and reduced but didn't eliminate the problem. David Clark then developed a material it called Fypro. A new coverall in Fypro replaced the Nomex item. Coloured dark chocolate brown, it killed unwanted cockpit reflections, but did nothing to reflect internal cockpit heat away from the crew.

In 1977 the company developed the next generation of pressure suits, in the S-1030 series and with a high level of commonality between the U-2 and SR-71 programmes. Coloured Old Gold and designated S-1031C for the SR-71, they incorporated state-of-the-art textiles and were more durable and comfortable.

The suit's four layers consisted of an outer coverall of Dacron, which was durable, and tear and fire-resistant. A restraint/joint layer held the suit together through restraint lines and acted as a pressure boundary. A third 'bladder' layer performed rather like a tyre inner tube and was made of polyurethane. Finally, an inner scuff layer protected the inflatable bladder layer from scuffing against other clothing and the urine collection device (UCD). An optional thermal layer could be worn inside the suit, but this was usually discarded in favour of more comfortable long cotton underwear. This was worn inside out to prevent seams from pressing into the skin.

Again, the suit was built in 12 sizes and assumed the seated position when pressurized in order to aid cockpit mobility. Gloves completed the pressure seal and were attached via wrist hinges. The boots featured heel retraction strips that were connected by cable to the ejection seat on entry to the cockpit. The complete pressure suit system, including helmet, cost just less than $200,000 a copy and lasted 10–12 years, undergoing a complete stripdown overhaul every five years and a thorough inspection every 90 days or 150 hours.

▼ An SR-71B pilot trainer demonstrates the brake parachute system. A 42in. 'chute removed the brake parachute's cover, followed by a 10ft extraction 'chute that deployed the main. (Lockheed Martin)



▲ The 40ft main ribbon brake parachute provided rapid deceleration – some crews claim that this was in the region of -2G. (Lockheed Martin)

ESCAPE SYSTEM

Both crew positions were equipped with electrically adjustable ejection seats that were activated in an emergency by the 'D' ring located at the front of the seat. The rocket-powered seats automatically actuated their knee kickers, foot retractors and locking shoulder harnesses. The minimum criteria for safe ejection in the early days was ground level with the aircraft travelling faster than 65kt. Nonetheless, the system was designed for escape at extreme altitude. Its two-stage 'chute system consisted of a 78in. stabilizing 'chute that deployed immediately after ejection, provided that the altitude was greater than 17,000ft. At 16,800ft the stabilizing 'chute was jettisoned by a barometric mechanical release, the main 35ft parachute opening at 15,000ft. If ejection occurred below 16,200ft, the stabilizing 'chute sequence was bypassed and the main deployed at 15,000ft. Oxygen for breathing and inflating the pressure suit was provided from six 20in^3 bottles located in the back of the parachute pack; they provided enough oxygen for 30 minutes.

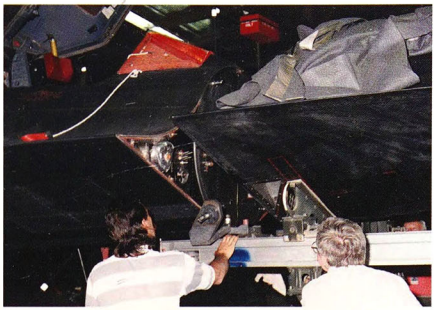
The oxygen system in the aircraft consisted of four 875 in^3 bottles, two for each crew position, and provided sufficient oxygen for 7.9 hours. Should the system fail, a back-up source was available from the oxygen in the parachute emergency system, the crewmember activating it by pulling a round green toggle referred to as the 'green apple'. The crew's pressure suit was ventilated by the aircraft's air conditioning system and the temperature regulated by an electrical heating element.

DRAG 'CHUTE SYSTEM

To aid braking after touchdown, a 40ft ring-sail ribbon parachute was located in a compartment on the top aft section of the fuselage. This could be deployed at a maximum speed of 185kt when the deployment switch in the cockpit was thrown. This action opened the two 'chute compartment doors, the left door pulling out the ripcord pin during the opening process. A spring-loaded 18ft pilot parachute then deployed, pulling out a 10ft parasail that in turn

pulled out the main drag 'chute. The parasail broke away from the main when the brake force exceeded 80lb.

The pilot could jettison the brake 'chute by moving the 'chute switch to the jettison position, an action necessary before the aircraft had slowed below 20kt to ensure that the heavy parachute attachment ball was pulled clear of the rear fuselage to avoid possible damage.



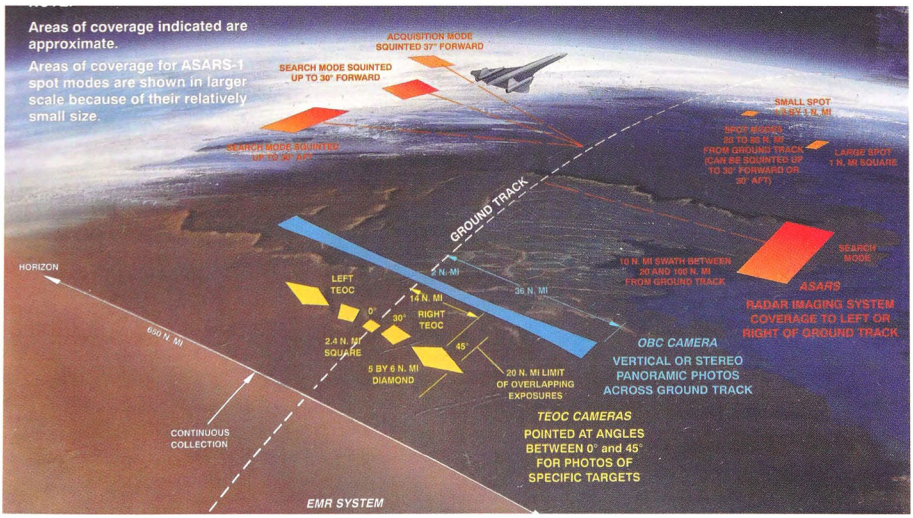
▲ Maintenance technicians remove the nose section of 61-7956 during PDM at Palmdale. (Mike Relja)

MAINTENANCE

Keeping this extremely complex aircraft flying required enormous dedication from ground technicians of the highest calibre. Former SR-71 maintainer Mike Relja gives a unique insight into just what it took to 'keep 'em flyin'.

After several TDYs to DET 1 as a crew chief, I returned to Kadena on the first Permanent Change of Station [PCS] package in 1976 to 1980, and spent all that time in Maintenance Control and ended up being the non-commissioned officer in charge of Maintenance Control at DET 1.

We would get the next month's proposed operational flights (called Hard Missions) the month before in a classified message from the Strategic Reconnaissance Center at SAC HQ. It would give us the proposed flight days spread out over the up-coming month by day flights and night-time flights. I would put little black tick marks for daytime flights and red tick marks for night flights on my desk calendar so I wouldn't have to go to the safe all the time for the message: only I knew what those little marks meant.



▼ Approximate synoptic data collection coverage from 80,000ft. (Lockheed Martin)

▲ A PDM for '956 progresses as the engines and inlet spikes are removed, together with the upper wing surfaces, ANS, canopies, ejection seats and nose section. (Mike Relja)

Other operational flights could be added depending upon worldwide/area situations prevailing at the time. This was done via secure voice telephones in Flight Operations during normal daytime operations or Maintenance Control after normal hours – Maintenance Control was manned 24/7/365. Maintenance flights could be added as needed, depending on the aircraft maintenance.

Actual tasking would come in the day before the scheduled flight day, from Flight Operations/Mission Planning. It would show the tail number, required sensor load, fuel load, take-off time and duration, crew names, etc. If two aircraft were required for a particular mission, we'd generate two aircraft at the same time – called a Hard and a Back-up. Sometimes the sensor configurations were the same for both aircraft, on other occasions one might require a 'radar nose' and the other a 'photo nose', depending on weather conditions expected over the denied area.

Maintenance sensor shops would start their preparations in their shops, while the crew chief and his maintenance crew would start prepping the aircraft. One of the first things accomplished would be a Pre-launch Operational Check (PLOC) engine run on the selected aircraft. The crew chief and his crew would do the run in the hangar, checking everything that could be accomplished at that power setting (idle to engine fuel de-rich check).

Hydraulics, generators, fuel boost pumps, flight controls, steering/brakes, engines were all exercised. The run would last around 20 minutes with the MRS tape system operated to allow tapes to be read afterwards for any maintenance items not caught by the crew chief during the run. If the aircraft hadn't flown for at least five days, we'd do this engine check regardless of the flight schedule. On one occasion I had an ADS/generator fail on one of my PLOC runs and had to accomplish all that maintenance work as well as all the pre-flight, sensor loads, servicing, etc, and we still made the flight the next morning.

After the engine run, if no maintenance items were discovered, the crew chief and his crew would start the inspection phase of the pre-flight. For this the aircraft was broken down into four mechanical areas. Mechanic 1 had the nose, NLG [Nose Landing Gear], NLG wheel well, C-bay, aft fuselage FS 715 to 1355, fuel tanks, drag 'chute, mixer compartments and forward cockpit.

Mechanic 2 had the right/left fuselage chine areas, all the mission bays K/M/P/S/Q/T/L/N/R/E/D, the aft cockpit and AC-bay.

Mechanic 3 had the left MLG [Main Landing Gear] and wheel well, left spike and inlet duct, lower left wing, engine, nacelle, upper left wing, engine, nacelle, and 'rudder', including 'rudder' stub fin.

Mechanic 4 had the right MLG and wheel well, right spike and inlet duct, lower right wing, engine, nacelle, upper right wing, engine, nacelle, and 'rudder', including 'rudder' stub fin.

Several specialist shops also had pre-flight inspections to accomplish. Electrical installed the aircraft battery and conducted checkouts. The Auto Pilot shop had the DAFICS/INS checkout, ANS aligning and loading pre-set destinations, MRS checkout, photo checkout if carrying cameras, environmental system checkout, communication systems (UHF 1 & 2, VHF, HF, TACAN, ILS, Intercom).

While this was going on, we also had our servicing to accomplish: liquid oxygen (no power on or anyone else on-aircraft at that time), chemical ignition system (CIS) (TEB) (again no one else on the aircraft and no fuelling at that time), lubrication of the NLG (after refuel), fuel (most times a 45K [45,000lb] load or if it's a rocket ride [without air refuelling] 65K after purging fuel tanks YO YO), liquid nitrogen (LN2), hydraulics, gaseous servicing N2 bottles, tyres (tyres were serviced 6–8 hours before take-off and then again 2–3 hours before take-off), accumulators etc, cockpit cleaning.

▲ With '956's PDM almost complete, the aircraft is pictured in the fuel barn. Here hoses were connected to the Y manifolds where the engines would be hooked up if they were installed. The aircraft was then fuelled full (80,000lb of JP-7) and the complete flight envelope simulated, checking tank sequencing. With the tests done, the fuel was pumped back into underground storage tanks. The hydraulic lift raised the aircraft's nose wheel leg, putting the aircraft in a 7° nose-high attitude to simulate flight at Mach 3+. (Mike Relja)

In between all of that you had your sensor shops trying to upload their sensors and check them out. Hopefully you didn't have a nose change (radar to photo or vice versa), as this threw in a little more work to your already busy schedule.

From start to finish (launch), you were looking at a good three-shift operation, starting with dayshift and continuing through swing shift and mid-shift depending on how well it went maintenance-wise. Some sensors required a pre-heat period (18 hours for the OBC), so power and air on the aircraft were required prior to launch; TEOCs were a 6-hour pre-heat time. A good 24-hour period of work by at least 25 people was required to accomplish this, and if the mission was scheduled as a Back-up, then this would generate double the workload.

MAN HOURS PER FLIGHT HOUR

In the early days of SR-71 flying there were more periodic inspections with less flight time in between, until the aircraft became more reliable and personnel gained experience. Back then, the man-hours per flight hour ratio was about 735.

After many years of operation in which crews and maintenance personnel gained experience and improvements were made to the aircraft, the time between teardowns was extended. Reliability increased and with no significant problems emerging during inspections, the man-hours per flight hour ratio fell to around 125 hours.

PROGRAMMED DEPOT MAINTENANCE

I got to Flight Test/PDM in 1981 while I was still in the USAF and assigned as the Air Force Quality Assurance Representative [AFQAR], performing quality assurance acceptance for DET 6 on the flight test and PDM aircraft that came through. When I retired from the Air Force in 1988, Col Don Emmons hired me back as a GS12 civil servant, and I worked as the Air Force Project Administrative Officer [AFPAO] on the PDM aircraft.

▲ Technicians work on '956's under surfaces. Note the two empty equipment bays (T and S) in the forward fuselage. In the SR-71A each of these would have housed a TEOC, or DEF H in the right bay (T) and a TEOC in S-bay. Also note the chalk marks at the various fuselage stations. (Mike Relja)

This programmed depot work was pre-negotiated and funded, but any discrepancies found by Lockheed during the performance of the inspections, service bulletins, time changes, functional checks, etc, were considered 'over and above'. I had a budget of around $1.1 million per aircraft to pay for those discrepancies. I had the option of saying 'work' or 'don't work' the discrepancy, if I thought it was minor or cosmetic in nature.

If I decided to have Lockheed work the discrepancy, I'd negotiate the man-hours with the Lockheed supervisor involved. If we couldn't come to an agreement, we'd send it up the chain, he with his Lockheed people, and me to the DET 6 folks. This was in place from 1988 until the Senior Crown programme was terminated. Prior to that Lockheed would fix everything, they'd write it up and then send the bill to the Air Force. When the USAF budget was cut back, we went to the above system of negotiating the 'over and above' discrepancies.

The PDM contract was negotiated a year in advance, so the FY89-90 PDM contract was negotiated on 11/12 August 1988 for example. The man-hours for each task on the incoming PDM aircraft would have an ADP proposal, a DET 6 position, and the negotiated hours.

The PDM schedule for the FY89-90 timeframe was aircraft 61-7980, 61-7971 and 61-7956. 61-7980 was completed in September of FY89, 61-7971 was started in May of FY89 and completed in February of FY90, and 61-7956 was started in October of FY89 and was scheduled for completion in July of FY90. However, due to program cancellation the PDM was terminated in November of 1989 and the B model placed into storage. The second effort to complete the B model PDM started in October 1990 and was completed in July 1991.

The aircraft were due a PDM every 800 flying hours, which would mean I would see a particular tail number every four years, depending on the flight schedule SAC put it through. At the time of cancellation there was talk based on the fact of not finding significant problems during previous PDMs to move the time out to 1,200 flying hours or maybe higher. The aircraft would be in PDM for 9–10 months, depending on the amount of work programmed for that tail number.

Using 61-7980 as an example, as per the contract, we would complete the following inspections: time changes, service bulletins, fuel tank repair, general PDM items – paint systems, functional tests, SRA-CP-141 FCP Center Stand x-ray, fuel leak checks, left/right nacelle, NLG door split line germ seal replacement. We would complete at least two FCFs with two hot legs each, and then make a delivery flight back to Beale after paint.

Depot Maintanance Tasks	
Task	**Man-hours**
Inspection Group 1 Pre-flight/Post Flight	1,350 man-hours
Inspection Group 2	400 Hour
PE [Periodic Inspection]	1,200 man-hours
Inspection Group 3 Depot Level	4,500 man-hours
Inspection Group 4 Depot Level 2400	125 man-hours
Inspection Group 5 Depot Level 4100	7,175 man-hours
Inspection Group 6 Seat Track Holes	16 man-hours
Fuel Tank Repair Fuselage/Inner Wing	6,300 man-hours
Fuel Tank Repair Outer Wing	3,000 man-hours
Fuel Tank Repair Wet to Dry Bay	480 man-hours
Tank Shims	
General Painting	150 man-hours
System Functional Test	6,400 man-hours
SRA-CP-141 Center Stand	140 man-hours
Fuel Leak Checks	40 man-hours
Left and right Nacelle/NLG Door Split	116 man-hours
Line Germ Seals	
Time Change Group 1	825 man-hours
Time Change Group 2	150 man-hours
Time Change Group 3	80 man-hours
Modification Group 1, 3 inch ADI	230 man-hours
Modification Group 2	97 man-hours
Palmdale Inspection	4,000 man-hours
Burbank Support	1,180 man-hours
Pool Charges @ 1.3%	395 man-hours

When we delivered 61-7980 the summary report was:

Duration	9 months
Total Man-Hours	27,548
Total Removals	2,233
Total Squawks	2,261
Total E.I.'s	229
Total Service Bulletins	27
Total Time Changes	209

All the above PDM work is quoted from the *SR-71-6 Aircraft Scheduled Inspection* and *Maintenance Requirements for SR-71, SR-71B and SR-71C Aircraft*, as well as the negotiated PDM Contract.

CHAPTER 9

FROM RS TO SR AND BEYOND

During the initial stages of assembling the YF-12A, it became apparent to Skunk Works engineers that the basic interceptor airframe could be adapted to produce a strike bomber. Rus Daniell approached Kelly with the idea and was asked to write a basic feasibility report. Having reviewed Daniell's document, Kelly Johnson began work on the idea that he referred to as the RB-12 (RB for 'Reconnaissance Bomber'), on 14 September 1960.

In January 1961, he took his unsolicited proposal to Washington and dropped it on the desk of Under Secretary of the Air Force, Dr Joseph Charyk. Charyk then summoned Col Horace Templeton from the Air Development Center at Wright Field, Ohio to Washington and asked him to complete an engineering analysis of the proposal. Lacking the required detailed knowledge of integrated bomber systems, Templeton recruited into his team Maj Ken Hurley.

This proved to be an extremely insightful move, but it placed Hurley in a tricky position as he was instructed to continue with his important 'white world' Air Force work on stand-off weapons for the North American RS-70 reconnaissance-strike bomber (later rechristened B-70) while also working on the black world Lockheed proposal. To further complicate matters, he was to report inw parallel to his boss at the Pentagon, Col David Jones and Col Templeton, while under the strictest orders not to inform Jones about his 'other job', since Jones wasn't cleared into the programme.

61-7955 was the second systems test aircraft for the Air Force. It first flew on 17 August 1965 and accumulated 1,993.5 hours before being flown into retirement by Col Tom Tilden and Col Bob Flanagan on 28 January 1985. (Lockheed Martin)

Just ten weeks later, Templeton's team took its refined proposal, which it referred to as the RS-12, back to Charyk. He liked what he saw and instructed them to present it to the Skunk Works boss at Burbank. To his enormous credit, Johnson too was extremely impressed with how the team had enhanced the capability of his original design, and as a result shelved his RB-12 proposal in favour of the team's RS-12 design.

Pentagon staffing of the initiative became the province of the Chief of Special Activities, Col Leo Geary, and Lew Meyer, a Special Projects finance officer. The Air Force selected two competing teams (Westinghouse and Goodyear) to provide radar and weapons system integration, requiring them to work in isolation. It was proposed that each RS-12 would carry a single nuclear weapon internally. It would be based on the Hughes GAR-9/AIM-47 missile (as carried by the YF-12A) and equipped with an adaptation of the Polaris A-3 1Mt warhead.

Under SAC's SIOP, to be implemented in the event of a nuclear war, the RS-12's concept of operations would require the aircraft to penetrate enemy airspace at Mach 3.2 and 80,000ft, use its radar to search designated areas, then locate, identify and strike selected targets. Using the GAM-87 ANS that had been developed for the subsequently cancelled Skybolt ballistic missile, the Air Force and Skunk Works teams confidently predicted that an RS-12 with an all-weather, radar-guided missile would be capable of hitting its target within a 50ft CEP and just 20ft CEP using an optical system to guide a missile launched from 80,000ft and distance of 50 miles.

There remained, however, significant doubters. Secretary of Defence Harold Brown rather pompously proclaimed that the entire proposition was ridiculous and that 'finding a target along a 3,000 mile track in a swathe 20 miles wide was like quickly locating a single word in the *Encyclopaedia Britannica*.' Viewed in such simplistic terms, target-finding and pin-point strike accuracy was certainly an ambitious undertaking, but the proposed RS-12 was intended to look for en route cues that would lead it directly to its specific targets.

Even Kelly was sceptical. Rus Daniell recalled a conversation with his Skunk Works boss during a return flight from Washington to Burbank in the company JetStar. 'Kelly turned and asked, "Do you still think you can hit that garage door down there, Rus?"' Daniel replied in the affirmative, adding, 'What you don't do is aim, shoot and forget. Like your car, you don't point it at your garage from the parking lot at work, close your eyes and drive.'

On 14 May 1962, Charyk flew to Burbank to review progress to date. On arrival he was directed to the RS-12 mock-up, into which a prepared mission tape had been installed for a demonstration. The tape contained experimental side-looking airborne radar (SLAR) imagery taken from a B-58 Hustler as it flew 1,200 miles at Mach 2 over six western states. The radar map had been transposed onto a 35mm film and was moved through the back-seater's radar display at a speed that equated to Mach 3.

Charyk was briefed on how to work the cursor that would be placed over a target and then 'pickled' to feed information into the weapons system. He was then invited to 'fly' a mission and see at first-hand how, in the words of Secretary of Defence Brown, 'a single word in the *Encyclopaedia Britannica*' could be located when you knew how the system worked. He emerged from the cockpit 40 minutes later beaming – he had located and 'pickled' all 20 designated targets. The feasibility argument had been laid to rest.

On 4 June 1962, Rus Daniell, Col Templeton and a number of other Air Force 'recon people' reviewed a 90-day RS-12 study granted to the Skunk Works by the Air Force , as well as the RS-12's forward forebody Class 1 mock-up. Although this was concluded satisfactorily, a firm commitment to move ahead with hardware wasn't forthcoming. The problem was that the ballistic missile had come of age and considerable doubt was being expressed in some quarters about the long-term viability of bombers as a delivery platform for nuclear weapons.

SAC had retired more than 1,500 B-47s from the inventory and President John F. Kennedy had cancelled the proposed high-profile, multi-million dollar B-70 Valkyrie bomber

on 28 March 1961. (Only two prototypes of this large bomber were built for research and development purposes, and based at Edwards AFB from 1964 to 1969. An XB-70 was lost following a mid-air collision in 1966.) The upshot was that the RS-12 was never funded and came to nothing.

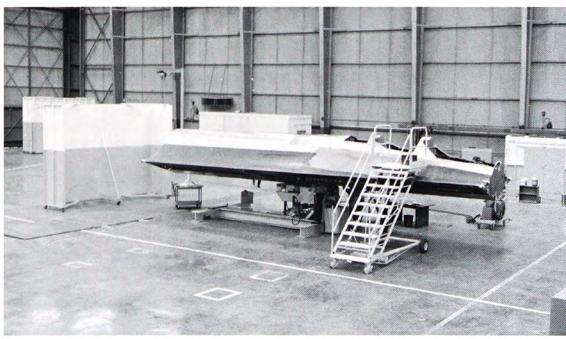
Undaunted, Johnson submitted other unsolicited bomber proposals to the Air Force. One such, referred to in-house as the B-71, was made to a small contingent of Air Force generals in April 1965. Another, made to representatives from the Defense Advanced Research Projects Agency (DARPA) on 23 October 1973, envisaged a modified SR-71 imparting massive kinetic energy to inert ordnance. Such weapons had no need for warheads, reducing their cost appreciably.

For example, a weapon weighing 1,200lb, launched at Mach 3.2 and 80,000ft on an optimum -0.5G trajectory could penetrate 23ft of reinforced concrete. This high-velocity projectile would cause virtually no collateral damage, but considerable damage to a subterranean target (like a bunker or missile silo) as the weapon's kinetic energy transferred to, and throughout, the structure. The same weapon could penetrate hard soil to a depth of about 120ft. Combined with a small high-explosive or nuclear warhead it became a highly effective sub-surface weapon, since the explosion would cause the soil above to collapse, maximising destruction and containing fallout in a nuclear scenario. Despite the concept's feasibility and moderate cost, it came to nothing.

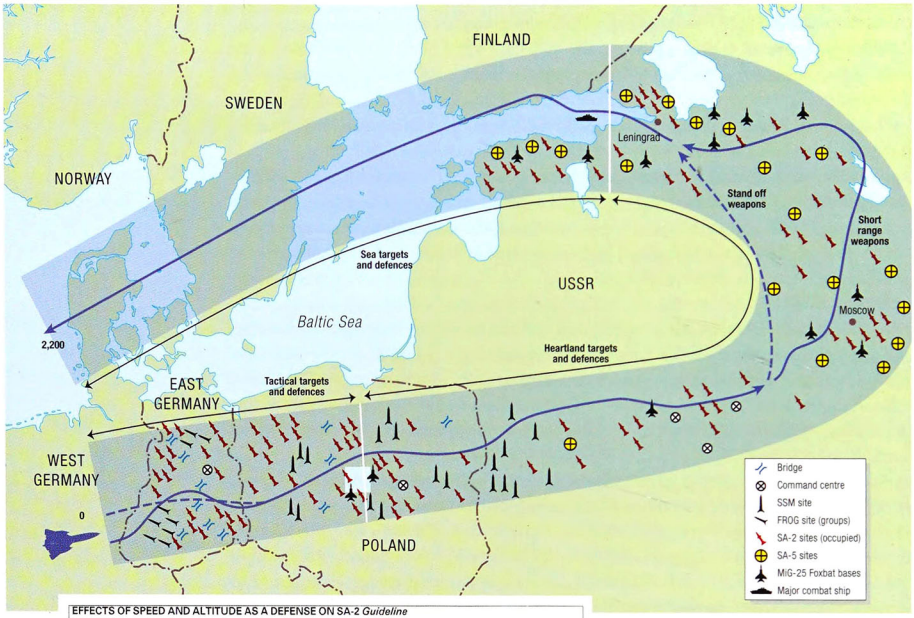
Undaunted, this didn't stop Johnson from submitting other unsolicited bomber proposals to the Air Force. One such, referred to in-house as the B-71, was made to a small contingent of Air Force generals in April 1965. Another made to representatives from the Defense Advanced Research Projects Agency (DARPA) on 23 October 1973 envisaged a modified SR-71 harnessing greatly increased levels of kinetic and potential energy to deliver inert weapons. Such weapons obviated the need for warheads, thus reducing the cost of the missiles appreciably. For example, a weapon weighing 1,200lb launched at Mach 3.2 and 80,000ft on an optimum –0.5g trajectory had the ability to penetrate 23ft of reinforced concrete. This high-velocity projectile would cause virtually no collateral damage, but considerable damage to a subterranean target (like a bunker or missile silo) as the weapon's kinetic energy transferred to, and throughout, the structure. The same weapon could penetrate hard soil to a depth of about 120ft. If combined with a small high-explosive or nuclear warhead, it becomes a highly effective sub-surface weapon, as the explosion causes soil above to collapse, and thus contain fallout in a nuclear scenario. Despite the concept's feasibility and moderate cost, however, they all remained 'paper only aircraft'.

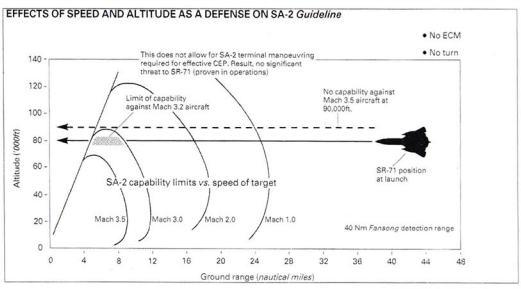
R-12 THE UNIVERSAL AIRPLANE

On 6 December 1962, Kelly Johnson noted in his log: 'Working on R-12 *Universal* airplane, using company work order. Can get no decision on any military version of the aircraft, but there does seem to be considerable interest in it.' Johnson's rationale for this design was based on the premise that if he produced a single platform capable of performing the reconnaissance, recon/strike or intercept roles depending on customer



▼ The full-scale engineering mock-up of the SR-71A forebody. (Lockheed Martin via Tony Landis)





▲ Composite B-12 Mission over eastern Europe for comparison of systems.

needs, it would greatly simplify production, and 'it eliminates the necessity of the Air Force deciding which version they want to buy.'

Seven days later the Skunk Works was visited by several SAC personnel, and Johnson logged that 'they wanted to see what kind of a reconnaissance version would meet SAC's needs... We prepared our proposal for a 140,000lb reconnaissance airplane capable of carrying 4,300lb of reconnaissance gear and gave it to Col Templeton with a forwarding letter.'

On 20 December, Kelly noted that he and several of his engineers flew to Washington to continue their contract pursuit. 'Presented our R-12 version, which Templeton and group presented to the Air Force in a closed session the next day. The outcome was that we were proposing too heavy an aircraft, with too much equipment, so we were requested to scale it down to 1,500lb of payload.'

Further design refinements of the R-12, primarily under Rus Daniell, continued, and were finally rewarded on 18 February 1963, when Lockheed was awarded pre-contractual authority to build six R-12s, on the understanding that an additional 25 would be ordered by 1 July.

A classified memo dated 15 February 1963 to John McCone (DCI) from Dr Charyk, now Director of the National Reconnaissance Office, noted how the new reconnaissance

programme would be funded. 'We have recently had approval by the Secretary of Defence for a 138,000lb, two-place reconnaissance version of the basic A-12 design, to be known as the R-12.

'Your organization in three previous instances, the U-2, the A-12 and the AF-12 [the long-range interceptor version], has acted as a procurement agent for the Air Force.

'Inasmuch as the decision has already been made that the R-12 program will be administered in the black, it is requested that you again perform as the procurement agent for the R-12.

'A memorandum of understanding similar to that existing for the AF-12 program is being drawn up and will be reviewed with the appropriate personnel in Dr Scoville's office in the immediate future.'

The first mock-up review of the new reconnaissance aircraft took place on 13/14 June 1963, and Johnson noted, 'I think the Air Force are well impressed with our operation to this point.' Another mock-up conference took place on 11 December, and was again deemed a success by Johnson. By 18 March 1964 construction was moving ahead rapidly, but contract negotiations with the Air Force had yet to be concluded.

Johnson noted in his log: 'Spent several days ... on ... the first six R-12s. It is extremely difficult to get a reasonable profit for what we do and no credit is given for the fact we operate more cheaply than the others.' Eventually agreement was reached, and with an aircraft production rate set at one aircraft per month for 31 months, the programme was completed under budget at a cost of $146 million (approximately $1.5 billion at today's values). This excluded engines and sensors, but included Categories I, II and III of the flight test programme – a remarkable achievement by any standards.

On 29 February 1964, during the run-up to that year's presidential election campaign, and in response to a challenge by Republican candidate Senator Barry Goldwater that the Democrats had neglected the defensive needs of the country, incumbent President Lyndon B. Johnson revealed the existence of the 'A-11' [A-12] programme. Five months later, on 25 July, in yet another piece of electioneering, Johnson made a second announcement about another hitherto black world aviation programme:

> I would like to announce the successful development of a major new strategic manned aircraft system which will be employed by the Strategic Air Command. This system employs the new SR-71 aircraft and provides a long-range advanced strategic reconnaissance plane for military use, capable of worldwide reconnaissance for military operations. The Joint Chiefs of Staff, when reviewing the RS-70, emphasized the importance of the strategic reconnaissance mission. The SR-71 aircraft reconnaissance system is the most advanced in the world. The aircraft will fly at more than three times the speed of sound. It will operate at altitudes in excess of 80,000ft. It will use the most advanced observation equipment of all kinds in the world. The aircraft will provide the strategic forces of the United States with an outstanding long-range reconnaissance capability. The systems will be used during periods of military hostilities and in other situations in which the United States' military forces may be confronting foreign military forces.
>
> The SR-71 uses the same J58 engines as on the experimental interceptor previously announced, but it is substantially heavier and it has a longer range. The considerably heavier gross weight permits it to accommodate the multiple reconnaissance sensors needed by the Strategic Air Command to accomplish their strategic reconnaissance mission in a military environment.
>
> The billion-dollar program was initiated in February of 1963. The first operational

aircraft will begin flight-testing in early 1965. Deployment of production units to the Strategic Air Command will begin shortly thereafter.

Appropriate members of Congress have been kept fully informed on the nature of and the progress in this aircraft program. Further information on this major advanced aircraft system will be released from time to time at the appropriate military secret classification levels.

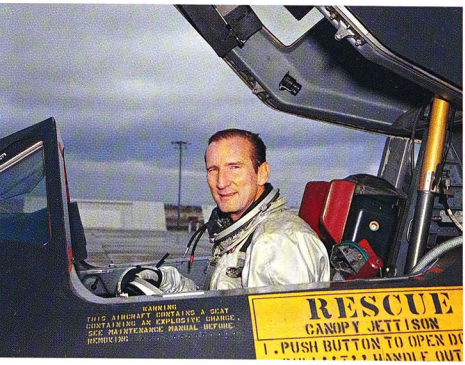
The announcement was a calculated political risk, as the aircraft had yet to undertake its maiden flight. It is also the first known instance of the Air Force's designation 'SR-71' being used. Research has been unable to establish exactly when the aircraft's role designator was changed for 'strategic reconnaissance', or who was responsible for the change.

For many years it was believed that when President Johnson made his 25 July announcement, he made a mistake and should have said RS-71. This is now proven incorrect, however. Audio tapes of Johnson's speech record that in all three places where the president said 'SR-71', his text stated 'SR-71'. However, the stenographer's copy of the speech, which was circulated to the world's press, transposed SR-71 into RS-71, thus giving rise to the 'error legend'.

FIRST FLIGHT PREPARATIONS

In August 1964, Kelly phoned Bob Murphy and asked him if he wanted to work on the SR-71 programme. At the time, Murphy was a superintendent in charge of D-21 drone production. Drone number one was undergoing final checkout, while another nine were at various stages of assembly. Bob accepted the offer and was immediately briefed by Kelly, who said, 'I want you to go to Palmdale and get Site 2 away from Rockwell. Hire the people you need. The pieces of the SR-71 will be up to you on November 1st and I want her flying before Christmas. Oh, I also want you to move up there because I don't want you to commute.' This was typical of the way Kelly operated. The next day, Murphy went out to Palmdale and met the base commander, who arranged a meeting between the various parties affected by their activities. Murph recalled:

▼ Dutch 51, Bob Gilliland was Lockheed's chief SR-71 test pilot. He is seen here in an early S-901 pressure suit. (Lockheed Martin)



Rockwell controlled all three sites; they were using Site 1 and Site 3 for B-70 production. Site 2 housed various other facilities, including a paint shop and a huge telephone exchange. The meeting got under way and I began negotiating for various parts of the building that would have to be vacated by specified dates to allow our people to move in. One of the Rockwell people said, 'Well we don't have anything from the Air Force that says we need to be out of this building.' At that point I bluffed a move to get out of my chair and said, 'You don't?' Well I'd better call Washington and find out what the heck is going on.' The ruse worked and he said, 'Wait a minute, we don't have to get Washington involved in this,' and I was able to complete the arrangements without having any official orders to do so – although they were probably just around the corner.

So it was that Lockheed inherited Site 2 (Air Force Plant 42, Building 210) at Palmdale, California. The prototype SR-71A (Article 2001, 64-17950) was delivered in disassembled

form in two large trailers on 29 October 1964. At that point Bob Murphy's team 'went into overdrive' in an attempt to fulfil the extremely tight deadline set by Kelly.

In the summer of 1964, Kelly had offered test pilot Robert J. Gilliland the post of chief project pilot for the SR-71. It was a position that Bob was admirably qualified for, having gained a great deal of experience as a member of the F-104 and A-12 test teams. In early December, Kelly and Bob flew from Burbank to Palmdale in Lockheed's corporate JetStar to review the progress toward final assembly. Murph escorted them around Building 210, revealing in the process that Article 2001 was spread all over the hangar floor.

During the return flight to Burbank, Bob (who was mindful that a number of Air Force generals from Omaha, Wright-Patterson and Washington were planning to be on hand at the 21 December maiden flight) told Kelly, 'Maybe we'd better postpone this thing 'til after Christmas? It's likely to be a little embarrassing to you, me and the Skunk Works if we get them out here and don't go.' Kelly refused to budge, contending that if he postponed schedules every time he was asked, the aeroplane would still be in the jigs.

Dick Miller led the flight test engineering effort for the entire contractor test programme. Once his brief had been decided upon and approved, he became responsible for the implementation of specific tests to be completed on individual flights. During those final weeks leading up to the first flight, Bob Gilliland recalled having to attend frequent meetings that he characterized as being 'tedious and in great danger of causing analysis-paralysis'. There was considerable discussion as to whether the first flight should be flown at subsonic speeds with the gear down, or whether the gear should be retracted and (if all went well) the aircraft should be flown supersonically. It was agreed that no dead-stick (power-off) landing would be attempted if there was a serious problem on the first flight and that the aircraft would not be landed on its belly if the gear failed to extend. Ejection was the preferred option in either case. Kelly and Bob agreed that an attempt would be made to fully exercise Article 2001 on its first flight.

With its two J58s installed, '950 conducted its first engine run on 18 December 1964. Three days later, a 'non-flight' was conducted. All pre-flight checks were carried out as if the flight was really going to leave the ground. This checkout included firing up both engines; checking control movements; a close scrutiny of gauges, lights, switches and indicators; and external checks for hydraulic leaks or other abnormalities. Finally, after testing trim movement, centre of gravity and radio operations, Bob taxied out to use the brakes and nose gear steering.

He did full engine run-ups at the end of the runway and took the number one position for take-off as if he was going to launch. '950 was lined up for take-off, and Bob eased the throttles to full military power, checked engines 'in the green' and released the brakes. As the aircraft lurched forward, Bob engaged 'min burner' to feel the asymmetric 'pulse-pulse' of light up. The aircraft accelerated rapidly thanks to its light fuel load, and Gilliland snapped the throttles back to idle upon reaching 120kt. As he deployed the 40ft drag 'chute, the deceleration threw him almost as hard against the shoulder straps as a carrier landing. He jettisoned the 'chute at 50kt, turned off the runway and taxied back to the hangar. There were very few write-ups and the team knew that the aircraft was ready for its maiden flight.

On 22 December 1964, Gilliland (using his personal callsign 'Dutch 51') got airborne from runway 25 at Palmdale in the first SR-71. The back seat remained empty for safety reasons and many of the functions that would have been carried out by an RSO or a Lockheed systems engineer were 'jury-rigged' onto a special instrument control panel mounted in the pilot's cockpit.

After take-off, Bob immediately retracted the landing gear, reduced afterburners to 'min', turned right and continued his climb northbound over the Edwards test range until he levelled off at 20,000ft and 0.9 Mach. Lockheed's experienced A-12 test pilot (later to become the second pilot to fly the SR-71), James Eastham flew one of three F-104s that chased '950

to observe and assist if problems occurred. Two other Starfighters were flown by USAF test pilots Col Robert 'Fox' Stephens and Lt Col Walt Daniels. One of the jets was a two-seater and carried a photographer in the rear.

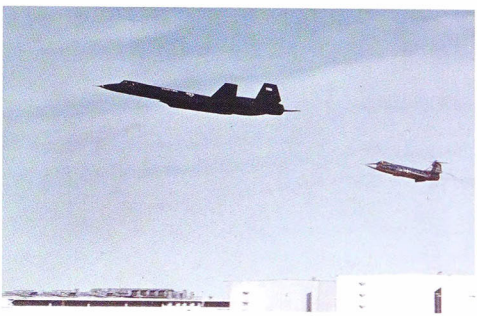
Immediately after Bob's take-off, Eastham tucked in to close formation on '950's right wing, allowing the two pilots to compare and calibrate the SR-71's airspeed and altitude readings against the F-104's, to verify accurate pitot-static system operations. The test flight instructions called for manoeuvrability and handling checks during 'static and dynamic' stability and control tests. These checks were carried out with the SAS axes 'on' and 'off', both 'individually' and then 'collectively'. Performance comparisons of predicted values of speed versus thrust and fuel consumption were also recorded, followed by a climb to 30,000ft, where cabin pressure, oxygen flow and temperature control were checked.

After passing Mojave, Bob turned left to fly on a heading west of NAS China Lake and then northward up the Owens Valley between the Sierra Nevada Mountains to the west and the White Mountains to the east (all within the Edwards SRA). Just north of Bishop (near Mammoth and Yosemite National Parks), Bob completed a 180° turn to the left and rolled out on a southerly track over the spectacular high cordillera of the snow-covered Sierra Nevadas.

It was now time for a supersonic dash, since all systems were performing well. Just northwest of Bishop, and with Jim's F-104 sticking to the SR-71 like glue, Bob eased the throttles into 'min' burner, checked the engine parameters, and slid the throttle levers up to 'max'. The light test jet accelerated very quickly to 400kt in level flight and on to supersonic speeds quite easily. At Mach 1.2 the master caution warning light flashed on, drawing Bob's attention to the annunciator panel where he saw a 'read-out' light identifying the problem as 'CANOPY UNSAFE'.

Visually checking the two canopy locking hooks on either side of the canopy, Bob verified that the canopy was really 'fully locked'. The pressure-sensitive micro-switches that transmitted the electrical 'unsafe' signal had been activated because an aerodynamic low-pressure area above the aircraft had sucked the canopy up against the locking hooks. It had risen high enough to complete the electrical circuit that turned on the annunciator and master caution lights. Bob correctly analysed the situation as 'safe' and pressed on with the test flight. He advanced the throttles once again and continued to climb and accelerate while rigorously scanning his instruments. On reaching 50,000ft and Mach 1.5, Bob eased the power out of burner into 'mil' and began deceleration to 350kt indicated airspeed, whereafter he descended to 20,000ft to allow the engines to cool.

As Bob approached Palmdale, he was advised by Test Ops that Kelly had requested a subsonic flyby down the runway. He and the accompanying F-104s streaked by to highlight the successful completion of the first flight. At the far end of the runway, Bob chandelled '950 up onto the downwind leg, where he dumped the gear and was most pleased to see the 'three little bright green lights' that indicated all three of the landing gear struts were down and locked. He turned onto a wide base leg and set up a long final approach at 185kt. After making a smooth touchdown on Palmdale's runway 25, he gently lowered the nose and deployed the drag 'chute. At 50kt Bob jettisoned the 'chute, turned off the active runway and taxied back towards the crowd of USAF dignitaries and Lockheed engineers and technicians who awaited his debriefing.



▼ With Lockheed test pilot Jim Eastham flying the F-104 chaseplane, Bob Gilliland completed '950's first flight on 22 December 1964 with a low pass. (Lockheed Martin)

After congratulations from Kelly and the others, the debriefing took place with more than two dozen

engineers and subcontractor representatives present. Bob narrated details of his flight chronologically from start-up to shutdown, after which Dick Miller's Lockheed engineers and the other companies' technicians asked clarifying questions. Since the session was recorded, Bob's description was prepared in a typescript that was circulated to all concerned. After this 'first quick look' was satisfied, a further analysis was made of canopy-mounted camera recordings that had viewed the instrument panel throughout the flight. All of this data, along with other 'automatic observation' enabled a Data Reduction Group under Bob Klinger to 'reconstruct' the flight for engineering analysis; so ended Bob's historic 'pre-Christmas' and most successful maiden flight of the SR-71.

Following the first three experimental test sorties, Dick Miller flew as flight test engineer on all the development flights except the limited structural tests, which were pilot-only for safety reasons. Aeroplane numbers '951 and '952 were added to the test fleet for contractor development of payload systems and techniques. With the Phase I Experimental trials complete, the Phase II Developmental test programme began and four other Lockheed test pilots were brought into the project: Jim Eastham, Bill Weaver, Art Peterson and Darrell Greenamyer.

Lockheed's concentrated developmental test efforts were matched by those of HQ Air Force Systems Command (AFSC) at Wright Patterson, where Col Ben Bellis had been appointed System Project Officer (SPO) for the SR-71. His task was to structure a 'Development and Evaluation Program' that would 'sound out' the new aircraft for the Air Force. Implementation of this programme would be undertaken by the SR-71/YF-12 Test Force at the Air Force Flight Test Center at Edwards. AFSC pilots would work in parallel with their counterparts from Lockheed and ensure the successful development of systems and sensors. Both Phase I Experimental and Phase II Developmental test flying had moved to Edwards, where '953, '954 and '955 were to be evaluated by the 'blue-suiters'.

In 1965 the team began SR-71 air-refuelling trials (supported by Beale's 903rd ARS); the aircraft proved adequate for skilled pilots to refuel. Flight envelope expansion proceeded well, as did a host of other tests. On 2 November 1965, Bob Gilliland and Bill Weaver completed the maiden flights of the first two SR-71B pilot trainers ('956 and '957). By the end of the year, Kelly Johnson could be justifiably pleased with the progress of the latest evolution of the A-12 family.

▲ On 16 May 1975, DEF J, an airborne defensive system installed in 955, participated in a test sortie flown by Tom Smith and Bill Frazier. SR-71A 976 flew as the target and a head-on crossover was made. Completion of the test sortie provided a rare photo opportunity for two Habus to fly in formation. In 955's log, however, it's noted that DEF J failed to see 976. (Lockheed Martin via Tony Landis)

AIRCREW RECRUITING

US Army Camp Beale was established as a military post in October 1942, when a vast site stretching over 80,000 acres was named in honour of Gen Edward FitzGerald Beale (a mid-19th century western explorer). Acquired by the newly formed US Air Force in early 1948, Camp Beale was used as a bombing and gunnery range during the Korean War. On 27 November 1951, General Order 77 reduced the bombing range by half and created Beale Air Force Base, which was later reduced to 23,000 acres. Between April 1957 and August 1958, USAF engineers constructed a 12,000ft strategic bomber runway at Beale, thus allowing the California base to become home to one of the first SAC B-52 wings.

The 456th Bombardment Wing (BW) operated its B-52s and KC-135s from Beale, alongside the 851st Strategic Missile Squadron's (SMS's) first-generation Titan ICBMs. After the 851st SMS was deactivated in 1964, the Air Force informed the press in October that the SR-71 would be stationed at Beale. Soon afterwards, an $8.4-million construction programme was initiated, which included the installation of an array of specialized technical support facilities and 337 new Capehart houses for the incoming personnel.

The official announcement of the new SR-71 unit was made a week before the first test flight of the SR-71, when CINCSAC, General John Ryan, revealed that the 4200th Strategic Reconnaissance Wing would be activated at Beale on 1 January 1965. Three months after the activation of the 'parent wing', four permanent support squadrons were formed: the 4200th Headquarters Squadron, the 4200th Armament and Electronics Maintenance Squadron, the 4200th Field Maintenance Squadron and the 4200th Organizational Maintenance Squadron.

Col John Des Portes was the commander of the new wing while construction works were being carried out at the base. The former U-2 wing commander was soon promoted to brigadier general and given command of the 14th Strategic Aerospace Division, after which Col Doug Nelson took over the SR-71 wing. Nelson was particularly well suited to his new command, since he had been SAC's project officer for the deployment of the U-2 nine years earlier and in August 1961 he had become director of operations for the Oxcart project. Three years later he received a telephone call from Lt Gen Archie Old (Commander of the 15th Air Force), who informed him that he was to be director of plans for the 14th Air Division at Beale, and take over the new wing when Des Portes' promotion was announced.

Nelson's immediate task would be to select a small group of highly competent sub-commanders and SAC fliers to form the initial cadre of the SR-71 unit. Thus he began the necessary planning for the activation of the world's first triple-sonic flying wing. After being assured by General Thomas Power that he would have top priority in choosing the right people for the programme, Nelson set about finding the best maintenance supervisors, flightline and shop personnel, and the best pilots and navigators. General Old agreed that Col William Hayes (later known as the 'White Tornado' for his shock of white hair) 'had to be' deputy commander for maintenance. Nelson recalled: 'Bill Hayes hit the ground running and immediately began selecting his team of maintenance supervisors, crew chiefs and system specialists. That Bill clearly realised our goal of putting together a top quality maintenance unit was evidenced by the outstanding results that his guys achieved within the first year.'

At the same time, Nelson was interviewing crewmembers for the flying squadron. He first recruited Lt Col Ray Haupt, a former U-2 pilot who was serving as head instructor and standardization pilot on Oxcart at Area 51. He joined the SR-71/YF-12 test force at Edwards AFB, where he became the first Beale pilot to be fully qualified on the SR-71. Ray was to be Beale's chief IP for all new SR-71 fliers.

Steadily, Nelson found the finest officers in SAC for his new, hand-picked organization. The 4200th Medical Group was to be commanded by Col Walt Wright, the most outstanding flight and orthopaedic surgeon in the Air Force. Colonel Clyde Denniston was chosen to supervise all the Category III flight test planning (to prove that the aeroplane could really do the mission for which it had been developed). Top-rated colonels and field grade officers were picked for unique staff positions, and before the end of 1965 the wing had been fleshed-out with the necessary talent 'to make it all happen'.

Meanwhile, Nelson was busy visiting the two B-58 units, the U-2 community, and HQ SAC to review the records of the best pilots and navigator-bombardiers among many highly-qualified SAC aircrew members. Many of those whom Nelson considered were SAC's 'select' crewmembers – those who had held spot promotions because of their proven status as SAC's best. Most of those considered were young enough to undertake another four years of new-generation flying.

From the start, SAC kept its Senior Crown programme as its exclusive preserve, restricting recruitment to select crewmembers from bombers and U-2s. The only exceptions were graduates from the Air Force Test Pilot School at Edwards. Meanwhile, Nelson selected ten B-58 crewmembers: pilots Al Hichew, Robert 'Gray' Sowers, Charles 'Pete' Collins, Ben Bowles and John Storrie, and navigator-bombardiers Cosimo 'Coz' Mallozzi, Richard 'Butch' Sheffield, Jimmy Fagg, Tom Schmittou and Dave Dempster.

They arrived at Beale to begin preliminary training after having completed the tough 'astronaut's medical exam' at Brooks AFB near San Antonio, Texas. Since there were no aircraft at Beale, it was arranged that the ten would undertake a seven-week training course on the SR-71 at the Skunk Works. They would be able to spend time with key Lockheed engineers, including Kelly Johnson and Ben Rich, and would write up lesson plans for a Combat Crew Training School that they would later establish at Beale. They would become the instructor cadre to train the SR-71 crew that would follow.

At the end of the Burbank course, Doug Nelson (who had been monitoring the progress of all ten) called them together and told them that since they were on a par with one another academically and professionally, he would have to make a purely arbitrary decision based on age. Since John Storrie and Dave Dempster were the youngest, they would get some preliminary flying time at Edwards and go to The Ranch for flying training in the 'Tin Goose' (the AT-12), prior to returning to Beale. Another crew would go back to Beale to get the flight simulator programme started and lessons planned for follow-on crew training.

At the same time, many others had applied to join the Senior Crown force. At Air Command and Staff College at Montgomery, Alabama, three former SAC select crewmembers who had flown B-47s and B-52s and one general's aide who had flown B-47s, were selected on the orders of CINCSAC General Joseph Nazarro, who instructed his Director of Personnel, Col Lester Miller, to use SAC's best resources to man the new system.

Consequently, Majs Jerry O'Malley, Don Walbrecht and Larry Devall, and Capt Connie Seagroves made the early cut without meeting Col Doug Nelson. Since there were no SR-71s at Beale, these early arrivals formed the flying squadron and managed the early activities at unit level (mobile control for T-38 flying, SR-71 simulator buddy-crew instructors, etc). As they had 'jumped the queue' and arrived ahead of all but a few of the B-58 selectees, General Des Portes interceded for his U-2 pilots and assigned them earlier checkout numbers than the B-47/B-52 inputs. As a result, U-2 pilots Pat Halloran and Buddy Brown got precedence, as well as test pilots Bill Campbell and Russ Scott. When the final crew list shaped up between late 1965 and early 1966 it read as follows, since Russ Scott had dropped out and others had arrived:

Crew 01: Maj John Storrie (B-58 and Capt Cosimo Mallozzi (B-58)
Crew 02: Maj Robert Sowers (B-58) and Maj Butel Sheffield (B-58)
Crew 03: Lt Col Al Hichew (B-58) and Maj Tom Schmittou (B-58)
Crew 04: Capt Pete Collins (B-58) and Capt Connie Seagroves (B-52)
Crew 05: Maj Jack Kennon (B-58) and Capt Cecil Braden (B-58)
Crew 06: Capt Bill Campbell (Test Pilot School) and Capt Al Pennington (B-58)
Crew 07: Maj Pat Halloran (U-2) and Capt Mort Jarvis (B-52)
Crew 08: Maj Buddy Brown (U-2) and Capt Dave Jenson (B-52)
Crew 09: Capt Dale Shelton (B-58) and Capt Larry Boggess (B-58)
Crew 10: Maj Jerry O'Malley (B-47) and Capt Ed Payne (B-47)
Crew 11: Maj Don Walbrecht (B-47) and Capt Phil Loignon (B-47)
Crew 12: Capt Earle Boone (B-58) and Capt Dewain Vick (B-52)
Crew 13: Capt Tony Bevacqua (U-2) and Capt Jerry Crew (B-52)

In addition, a number of other officers were on hand, or had been identified, for check-out positions some time in the future, but did not have crew identity until later. These pilots were Jim Watkins (KC-135), Larry Devall (B-52), Bob Spencer (U-2), Roy St Martin (U-2), George Bull (U-2) and Bob Powell (U-2). The RSOs were Dave Dempster (B-58), Clyde Shoemaker (B-52), Ruel (Keith) Branham (B-52), Bob Locke (B-52), John Carnochan (B-58), Charles McNeer (B-52) and Bill Kendrick (B-52).

The first five crews were still at Edwards and The Ranch getting some preliminary flying in T-38s and the AT-12 to become the first instructor pilots. Kennon, Braeden, Bowles and Fagg stayed on at Edwards with the test force.

A typical RSO candidate was Spot Maj Ed Payne at Mountain Home AFB, who had applied for the programme. His background was similar to that of most navigator-bombardier/RSO applicants at the time. He had joined the USAF only nine years before and had become a radar-bombardier on B-47 Stratojets. In 1962, as a 'spot-promoted' captain with the 303rd BW at Tucson, Arizona, he and his crew had won ten of 22 trophies at SAC's annual navigation and bombing competition. In May 1964 the 303rd BW deactivated, whereupon Ed was given orders to report to the 92nd BW at Spokane, Washington, which was equipped with B-52s.

> My squadron commander urged me to trade the assignment with another bombardier so we could retain our 'spot' promotions to major a year longer by transferring to Mountain Home, Idaho, where we could continue to fly B-47s. I accepted my boss's advice and moved to Idaho with the rest of our crew.
>
> One day later, at the Standardization Board Office where our crew was assigned as flight evaluators, a young crewmember beamed, 'I know where I'm going, I know where I'm going!' I looked at a copy of the message that told of the qualifications for entry into a strange programme. I talked over such an assignment with my wife Millie and the next day I completed an application for duty as an RF-101 'pilot'.
>
> Three weeks later I was notified that I'd been selected for an interview at Beale. The instructions informed me to travel in civilian clothes from Boise, Idaho to Yuba City, California. On the final leg of the flight, another passenger asked me if I was Payne, Vick or Jarvis. I admitted my identity, whereupon Larry Boggess introduced himself. 'How did you know who I was?' I enquired. "You're wearing a hack watch, Air Force sunglasses, and have a good haircut,' replied Larry, 'and those two guys up front must be Dewain Vick and Mort Jarvis,' he commented.

The interview at Beale was conducted in an old World War II building. A secretary in civilian clothes first called Dewain Vick into the office for the interview; he was followed by Mort Jarvis and me. Larry Boggess was last in that day. When I walked in and saluted, I noted that Col Doug Nelson was wearing an orange-coloured flight suit complete with an RF-101 patch. As the tall, slim colonel read through my personal records, he said 'welcome to Beale, Capt Payne'. Looking up, he saw my gold major's leaves and apologized for the mistake, to which I replied, 'Oh well, sir, easy come, easy go,' referring to the temporary nature of SAC's spot promotions.

Colonel Nelson told me he was indeed hoping for an all-spot team. The interview was very short. Nelson asked a few personal questions, then enquired whether all the RSO applicants were 32 years old with five children like me, since the other two had been! He then asked if I would be prepared to fly over enemy territory, to which I replied, 'Of course'. I was told that I had passed the interview and was 'hired' pending passing the physical examination in Texas.

Back at Mountain Home, Ed received orders to attend a ten-day medical exam at Brooks AFB, Texas in April. Prior to the exam he completed a 505-question paper asking all about his previous state of health. Ed recalled that the detail was 'incredible'. One question asked: 'Have you ever worked in or around a silo?' Since he had grown up on a Montana cattle ranch, he answered 'yes', and had to see a specialist at Brooks who checked him over for silo fever, a condition that a person working every day in wheat dust might contract from the poor quality air one would breathe. Ed explained that during a summer vacation from school he had worked as a carpenter's helper repairing a silo. Such was the detail of the examination, which was the same as that used by NASA in its selections for the astronaut programme.

He was given a clean bill of health and returned to Idaho. While he awaited further orders, it was announced that the 9th BW was to deactivate on 1 January 1966. On that date, Ed lost his spot promotion and returned to the rank of captain. He was in contact with Col Nelson at Beale, who told him that they had no aircraft to commence the training programme, but that the 4200th SRW was inheriting the 9th BW's 'historical number', which dated from World War I, so it would be called the 9th Strategic Reconnaissance Wing (SRW) after 25 June 1966.

On Nelson's instructions, Ed gathered up all of the 9th's heraldic items, pictures, trophies, battle flags, unit histories and other paraphernalia relating to the wing and its squadrons, the 1st and the 99th, and packaged them for shipment. Another RSO (Capt Connie Seagroves), who was already at Beale, came to Mountain Home in a DC-3 to collect the boxed treasures. Ed reported to Beale in April 1966 to team up with Maj Jerry O'Malley, who had arrived from Maxwell AFB ten months earlier.

The first two of eight Northrop T-38 Talon trainers arrived at Beale on 7 July 1965. These small, agile white jets (widely used as trainers with Air Training Command) would be used as 'companion trainers' to maintain overall flying proficiency for the SR-71 crews at a fraction of the cost of flying the main aircraft. They were also to be used as 'pace-chase' aircraft to accompany every SR-71 flight during the first year of Beale operations, to observe landing gear positions and to give crew and staff pilots an opportunity to practise formation flying. Because of the T-38's size alongside the SR-71, one of the wives jokingly called the two aircraft 'the horse and the horsefly' when they first appeared together over Beale.

Doug Nelson recalled that the T-38s were obtained only after a long and traumatic battle with SAC Headquarters over the companion trainer issue:

▲ Lockheed flight test aircraft 61-7952 was the first SR-71 lost in an accident. Pilot Bill Weaver miraculously escaped the 25 January 1966 incident, but flight test engineer Jim Zwayer was killed. (Lockheed Martin via Tony Landis)

Even though the need for such an aircraft to augment the SR-71 fleet had been clearly demonstrated in the A-12 programme in Nevada, I had considerable difficulty convincing some of the senior staff people at HQ SAC and at HQ 15th Air Force. I think the argument that finally won them over had to do with the fact that some of these same people had already been expressing the view that I should consider selecting SAC B-52 bomber and KC-135 tanker pilots for entry into the programme, as well as supersonic B-58 pilots, test pilots, U-2 pilots and former fighter pilots. I agreed that this could probably be done, but was really only feasible if they could be put through a 'lead-in' training course conducted by us at Beale in an aircraft such as the T-38. Other alternatives I suggested included the F-5B, F-101F and F-104B. They settled on the T-38 as the obvious choice and went all out to obtain eight of them from Training Command.

In December 1965, Maj Don Walbrecht flew Lt Col Ray Haupt to Palmdale, where Haupt and Charlie Bock (USAF acceptance test pilot at Edwards) picked up the SR-71B trainer (64-17957) from Plant 42 and test-delivered it a few miles away to Edwards, where it underwent further acceptance testing before it was ready for delivery to Beale.

At 1400 hours on 6 January 1966, Col Nelson and instructor pilot Haupt made the first pass of an SR-71 over Beale to deliver the trainer to SAC's 9th SRW. Soon after, Storrie and Collins would be able to finish their pilot checkouts. Four months later, Col Nelson and Maj Al Pennington took delivery of Beale's first SR-71A, 64-17958. From then on, crew training and Category III operational testing could proceed in earnest.

▼ Colonel Doug Nelson (second from right) takes formal delivery of Beale's first SR-71, two-seat trainer '956, from Palmdale plant manager Bob Murphy on 6 January 1966. (Lockheed Martin via Bob Murphy)

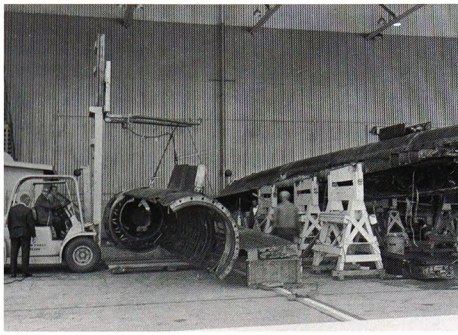
SR-71 LOSSES

On 25 January 1966, Bill Weaver and Jim Zwayer took off from Edwards in SR-71A '952 using call sign 'Dutch 64'. Both were Lockheed flight test employees. The two main objectives of their mission were to evaluate navigation and reconnaissance systems, and investigate procedures for improving high-Mach cruise performance by reducing trim drag. This research required that the CG be moved further aft than normal to compensate for the rearward shift of the centre of pressure at high Mach.

After in-flight refuelling, Dutch 64 climbed back to cruising altitude. While the aircraft was in a 30° bank to the right at approximately 80,000ft and a speed of Mach 3.1,

an inlet scheduling malfunction occurred, followed by an unstart of the right engine. The cumulative effect of the inlet malfunctions, CG configuration, speed, altitude and attitude resulted in pitching and yawing forces that exceeded the restorative authority of the flight controls and the SAS. This combination of rapid out-of-control actions led to the break-up of the aircraft, with the entire forebody becoming detached from the main body.

As soon as it became apparent that the situation was hopeless, Bill tried to tell Jim what was happening and to try and remain in the cockpit until they were down to a lower speed and altitude, since he did not think it would be possible to eject successfully under such stressful conditions. Unfortunately, as revealed upon subsequent recovery of the cockpit voice recorder, most of Bill's words were unintelligible due to the incredibly high G forces that both men were being subjected to at the time. At that point, Bill blacked out and to this day still does not know how he escaped. Indeed, his ejection seat was found inside the cockpit section of the wreckage.



▲ The SR-71A prototype was written off following an accident during an anti-skid brake evaluation on 10 January 1967. The remains of the forward fuselage and part of an engine nacelle are seen in storage at Palmdale. (Lockheed Martin via Tony Landis)

During the break-up, the cockpit canopies were blown off and a combination of G forces and air loads had blown both men clear, as Bill later explained:

> I thought I was having a bad dream and hoped that I would wake up and all this would go away. However, as I began to regain consciousness, I realized it was not a dream and that this had really happened. At that point, I thought I was dead because I was convinced that I could not have survived what had happened. I remember thinking that being dead wasn't so bad after all. I had a kind of detached, euphoric feeling. As I became more conscious, I realised I wasn't dead after all, and that I had somehow became separated from the aircraft. I couldn't see anything as my visor had iced up.
>
> My pressure suit had inflated, so I knew the emergency oxygen supply in the seat kit attached to my parachute harness was functioning. This source provided breathing oxygen and pressurization essential at those altitudes, and physical protection against the intense buffeting and G forces I had been subjected to. It was like being in one's own life support capsule. After realizing that I wasn't dead and that I was free of the aircraft, I was concerned about stability and not tumbling at such high altitude. Centrifugal forces sufficient to cause physical damage can be generated if the body tumbles at high altitude where there is little air density to resist spinning motions. Fortunately, the small stabilization 'chute, designed to prevent tumbling, had worked fine.
>
> My next concern was the main 'chute – would the barometric automatic opening device work at 15,000ft? I certainly hadn't made a proper exit – I knew I had not initiated the ejection procedure. How long had I been blacked out and how high was I? I was about to open the faceplate so I could estimate my altitude above the terrain and locate my parachute's 'D' ring. At that moment, I felt the sharp, reassuring tug which indicated that the main 'chute had deployed. This action was a very reassuring feeling, believe me.

▼ Colonel Doug Nelson accepts delivery of the 9th SRW's first SR-71A, '958, on 10 May 1966. (Lockheed Martin via Bob Murphy)

I then managed to raise my faceplate and noted that the visibility was just incredible. It was a clear winter's day at about three o'clock in the afternoon, and from my vantage point beneath the canopy it appeared that I could see for a couple of hundred miles. But what made everything just perfect was that about a quarter of a mile away was Jim's 'chute. I was delighted because I didn't believe either of us could have survived, and to think that Jim had also made it gave me an incredible lift.

I couldn't manipulate the risers to steer my 'chute because my hands were frozen and I needed one hand to keep my iced-up visor raised (the up-latch was broken). As a result, I could only see in one direction and the terrain wasn't all that inviting. I was convinced we'd have to spend the night out there and I was trying to think of things I had been taught in survival training. I landed okay and was trying to undo my parachute harness when I heard a voice say, 'Can I help you?' I looked up and there was a guy walking towards me wearing a cowboy hat and behind him was a helicopter. He turned out to be Albert Mitchell, whom I later learned owned the huge cattle ranch in northeast New Mexico upon which I had landed. He helped me out of the 'chute, told me he had radioed the police, the Air Force and the nearest hospital and then said, 'I saw your buddy coming down, I'll go and help him.'

He climbed into his little helicopter and was back a few minutes later with the devastating news that Jim was dead. I asked him to take me over to see Jim and after verifying that there was nothing that could be done, other than have his ranch foreman watch over the body until the authorities arrived, he flew me to Tucumcari hospital about 60 miles away to the south. I have vivid memories of that flight as well. I didn't know much about helicopters, but I knew a lot about red lines, and the airspeed needle was above the red line all the way to Tucumcari. I thought about the possibility of that little thing shaking itself apart in flight and how ironic it would be to have miraculously survived the previous disaster only to be finished off in the helicopter that had come to my rescue! We made it without mishap and on reaching the hospital I was able to phone Lockheed Flight Test at Edwards. They knew the aircraft had been lost after loss of radio and radar contact, and just didn't believe that I had survived.

The solution to reducing the excessive trim drag problem was to move the centre of lift forward, thus reducing static margin and trim drag; this was achieved by Kelly inserting a 'wedge' between the aircraft's forward fuselage and its nose section. The result was the distinctive 2° nose-up tilt.

During the closing stages of 1966, the SR-71 underwent a series of anti-skid brake trials. Bill Weaver conducted most of these and on 10 January 1967 was due to evaluate the system with the aircraft at maximum gross weight. By a twist of fate, he was unable to conduct this particular test because of the funeral of his friend Walt Ray, who had been killed a few days earlier in an A-12 accident. Art Peterson was substituting for Weaver and the RSO position remained empty.

During the trial, the aircraft had entered a flooded test area of the Edwards runway at well over 200kt, when the brake 'chute failed to deploy properly. The wheel brakes remained ineffective until the aircraft had cleared the test area and once on a dry surface, the brakes locked the wheels and all six main tyres blew. As momentum carried the aircraft onward, the brakes burned out and the magnesium wheel hubs were consumed on the concrete runway, triggering an even greater fire.

Peterson skilfully retained control of the stricken aircraft until he ran out of runway, albeit riding on the main gear stumps. On the overrun, one of the main gear legs dug into the dry

lakebed, causing side forces to rip the nose leg off. This sudden breakage stopped the aircraft and broke its back. Fire quickly spread to engulf the entire machine, but Peterson managed to extract himself from the cockpit, in the process sustaining back injuries that would ground him for several weeks. It was the end of the line for the SR-71 prototype, Article 2001 (64-17950), which was written off as 'beyond repair'.

◀▼ On 11 April 1969, Lt Col Bill Skliar and his RSO Lt Col Noel Warner experienced a wheel failure and subsequent fire on take-off from Edwards AFB. As seen in these frame grabs, Skliar managed to bring 61-7954 to a halt on the runway and both crew escaped unharmed. (USAF via Col Bill Skliar)

In mid-1966 Bill Skliar left the A-12 programme to become chief of operations for the SR-71 test force at Edwards The SR-71A prototype was written off following an accident during an anti-skid brake evaluation on 10 January 1967. The remains of the forward fuselage and part of an engine nacelle are seen in storage at Palmdale. (Lockheed Martin via Tony Landis). On 11 April 1969, Lt Col Skliar and Maj Noel Warner lined up SR-71A 61-7954 on runway 04 at Edwards and began a maximum gross weight take-off. 'Dutch 60' had just rotated when one of the left main gear tyres blew. The two remaining tyres were unable to support the aircraft's weight and burst immediately.

Bill aborted the take-off, but the burning shrapnel from the disintegrating magnesium wheel hubs caused a fire that rapidly engulfed the aircraft. He managed to retain control and halt on the runway. The worst of the fire was along the left side because a breeze kept the right side relatively clear; Skliar exited to the right and then assisted Warner from the rear cockpit as the fire began to billow around them. Both crewmembers survived, but '954 never flew again. After the incident, all SR-71 wheels were replaced with less combustible aluminium units, and B. F. Goodrich beefed up the high-speed, 239kt-rated tyres.

PITCH-UP ACCIDENT

On 18 December 1969, Director of the Test Force Lt Col Joe Rogers (an experienced test pilot with more than 200 hours on the SR-71) and RSO Lt Col Gary Heidlebauch were scheduled to fly 61-7953 on a routine test sortie. The aircraft had been undergoing extensive modifications to install a new ECM system, and this would be its first flight for many weeks. After air refuelling, Rogers initiated a pre-planned acceleration and climb. Soon after transitioning to supersonic flight, 'Dutch 68' experienced an explosion, accompanied by a loss of power and severe control difficulties.

As the aircraft decelerated, its angle of attack continued to increase despite Joe pushing the control stick 'hard against the firewall'. After slowing to subsonic speed, the fully fuelled aircraft became increasingly less controllable and both crew realized '953 had entered an irrecoverable corner of the flight envelope. Ten seconds after the explosion, Rogers knew it was time to go and ordered, 'Let's get out, Gary!' Both men safely ejected, while the aircraft (in a deep stall) pitched up. Soon after, '953 made its crater-grave near the southern end of Death Valley. The cause of the explosion remains unknown.

TRAINING AND CATEGORY III TESTING

Training techniques changed little over the 25 years of the SR-71's useful lifespan. The aircrew curriculum consisted of three phases of progressive activity that readied pilots and RSOs for the move from a variety of other jets into the highest performance aeroplane in the world. At first, crewmembers accumulated many hours in the flight simulator before beginning their inflight training.

The pilots, after completing the elongated simulator course during which they had endured every conceivable emergency procedure, and many T-38 flying hours, were introduced to the SR-71B, which they all recognized as 'friendly'. The B-58 pilots found it particularly easy to fly. Most other aircrew also found that flying the SR-71B was simply an extension of their former jet flying, no matter what principal type they had flown. The new pilots (under the supervision of Haupt or Hichew) found that the first sortie flown in the SR-71B was 'tame', and it proved both easy to fly and land.

The first training sortie was accomplished at subsonic speeds under the supervision of an instructor pilot, who evaluated the new pilot's 'first performance'. This indoctrination flight included touch-and-go landings and confidence-building manoeuvres that soon made the aircraft feel like an old friend. Two more instructor-supervised sorties followed, adding air refuelling practice, while a third included an acceleration to Mach 3.0 and a descent, an approach culminating in GCAs, ILSs and more landings.

The fifth flight was a three-hour evaluation sortie, which reviewed the student's total performance to assure that pilots were ready to take their own simulator-trained RSOs on six more crew-training sorties before both crewmembers could be declared 'qualified'. Sorties lasted between three and five hours and consisted of 'combat-oriented' missions that included emergency navigation legs at Mach 3.0 to demonstrate that large errors could develop unless headings were held for long distances.

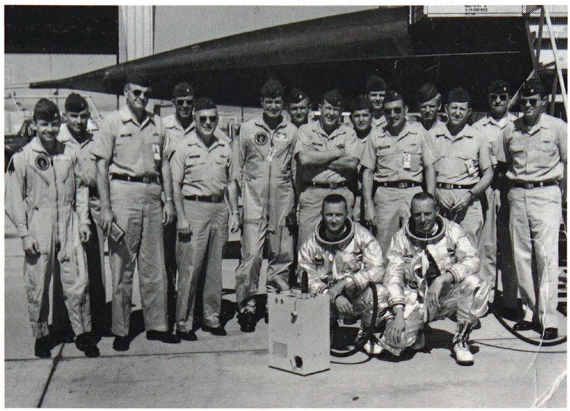
The crew then undertook a simulator check ride. This no holds barred evaluation tested the crew's ability to control serious inflight emergencies that involved flight judgment and crew coordination of high standards. A few days later, the crew flew a long profile, after which instructors reviewed every voice transmission made during the mission and the MRS record; their ability to fly a mission profile to the letter was evaluated by the use of the latter device. After crews were declared 'combat ready', they continued clocking up hours by performing Category III Operational Test Flights.

▼ Lt Col Joe Rogers and Lt Col Gary Heidlebauch both ejected safely from '953 before it crashed near Shoshone, California on 18 December 1969. (USAF via Tony Landis)

During operational testing, two major areas of concern were focused upon – the aircraft's inlet control system and the effects of the prolonged heat soaks during high-speed flight. As far as the former was concerned, crews were often subjected to sharp and distracting unstarts and an immediate solution to the problem was to operate the inlet system in the manual mode, with the pilot controlling the spike and door positions with switches while reading their changing positions on cockpit instruments. Such manual operations took up an undue amount of the pilot's

attention at high speed and resulted in off-optimum inlet operations, but though less efficient, they often allowed new flyers to complete more training missions and accumulate data for the Phase III test programme.

The SR-71 was not 'cleared' for top speeds during Cat III test flying and training for most of 1966, an initial restriction speed of Mach 2.6 being applied. By mid-year the limit was raised to Mach 2.8, and by December Mach 3.0 was allowed. Finally, in early 1967 all aircraft were cleared to fly at the design limit of Mach 3.2. Since SAC allowed its wing commanders to be fully qualified in their unit's aircraft, Col Doug Nelson teamed up with senior staff RSO Col Russ Lewis and formed 'Staff Crew Number One'. They undertook the full aircrew course at Beale, completing their certification in September 1966. Soon after, they flew SAC's first ever Mach 3.0 flight.



▲ This jovial group photograph was taken at Beale just prior to the first deployment flight to OL-8 at Kadena AB, Okinawa. (USAF via Col Don Walbrecht)

As training began in earnest around the western US, the Air Force began receiving lots of sonic boom complaints. Most of the heavy booms were attributed to operations in the ascent and descent phases when the SR-71 accelerated or slowed. The 'nuisance factor', rather than real damage, caused Congress to instruct the USAF to modify its training routes to avoid flying over large urban areas.

The township of Susanville situated just north of Beale on the 006° radial of the Sacramento VORTAC knew a great deal about sonic booms. During the first 18 months of flight operations, SR-71s were cleared by FAA flight controllers to accelerate and climb supersonically on that radial. On reaching FL330 and Mach 0.9, the pilot would push the nose below the horizon to quickly accelerate beyond the Mach while descending to FL270, before starting another climb at Mach 1.25. The intensity of a sonic boom is dependent upon the slant range from the aircraft to the ground along the shockwave, poor Susanville, nestled high in the Sierra Nevada foothills, sat directly in slant range and was taking a real hammering.

▼ 61-7953 was one of three SR-71s allocated to the Air Force flight test programme and was the second lost in an accident. (Lockheed Martin)

Prolonged flights in a full pressure suit could be uncomfortable, especially with a full bladder. For this reason, a urine collection device (UCD) was developed for a 'suit-dry' method of eliminating fluid body waste. Urine could be discharged into a condom-like receptacle that was tube-connected to a plastic collector bag donned prior to suiting up.

One crewmember described his pre-UCD inflight urination experience with the 'jug' in the following terms: 'Wearing

pressure-suit gloves, undoing several zippers and fighting through 4in. of pressure suit wasn't easy.' Maj Dave Dempster was on a 3-hour training sortie in April 1966 in '958, with Maj John Storrie, when he was confronted with a full-bladder problem. His S-901J pressure suit had not yet arrived from the Clark Company and he had borrowed a suit from a similarly tall colleague.

The demands of nature had become irresistible and Dave mentioned this unpleasant fact to John. Most crewmembers were very reluctant to use the 'jug' because (unlike with the later UCD) suit integrity was not maintained and bloodstream renitrogenation was likely. John, after devoting some thought to Dave's problem, said, 'Well, the way I see it, you can either hold it in or let it go in your suit – by the way, whose suit are you wearing?' Dave replied, 'Col Nelson's.' That thought provided him with all the encouragement he needed to wait until he landed!

The first two years of operating the SR-71 at Beale were crammed with training and testing activity. More and more crews were building up flying time and testing the aircraft's ability to do its intended mission.

In November 1966, Capts Earle Boone and Dewain Vick climbed into '966 for their first flight together. Their families were proudly witnessing the event from the Physiological Support Division (PSD) van. They had just cranked engines when one caught alight and fire engines converged on the 'hangar barn' from all points of the compass. The crew evacuated the aeroplane and the fire was quickly extinguished, with minor damage to the aircraft. Earle and Dewain transferred to another SR-71 and were able to complete their sortie; various problems caused the loss of up to 20 per cent of the early training sorties.

Precautionary landings away from Beale were also frequent during this early period. Typical of many diversions were those of Jerry O'Malley and Ed Payne, who landed at Hill AFB, Utah, with a generator problem. They recovered the very same aircraft into Buckley Field, Colorado a week later with the opposite generator inoperable. A few weeks later they lost a fillet shortly after take-off. The aircraft piece was found by a resident near Beale, who turned it over to the County Sheriff, who in turn passed the 9ft length of black skin back to the 9th SRW.

Base officials identified the missing part as belonging to Jerry and Ed's aircraft. As Jerry prepared to refuel near Walton Beach, Florida, he asked to pull farther forward so the KC-135 crew could look at the rear of his aircraft. The boomer had reported that 'the ass-end of the aeroplane was missing.' Since the aircraft had just transited the US without the slightest indication of a problem, and the boomer had relayed to the crew that 'the panel appeared to merely cover some plumbing,' Jerry refuelled with the intention of returning to Beale 'high and hot'.

Ed reported the crew's intention via HF radio to the Beale command post, whose officer controller passed the information on to HQ 15th Air Force and SAC. Ed got a return call from the 15th Air Force command post instructing him to divert into Barksdale AFB, Louisiana – this order was not queried as it came from Lt Gen P. K. Carlton, commander of the 15th Air Force.

Jerry landed on the southern end of Barksdale's long runway, jettisoned the drag 'chute at 50kt and switched off the anti-skid brakes, as per the checklist. At that point, the SR-71 entered a 1in. deep puddle of rainwater and slewed into a sideways skid down the runway. As it exited the hydroplaning skid and touched dry runway, all six tyres blew. It was three days before Jerry and Ed could return to Beale. When they suited up for the flight home, PSD technicians accidentally interchanged their 'moon suit' helmets, which caused acute discomfort to Jerry on the four-hour slow flight back to northern California.

FIRST BEALE ACCIDENT

On 13 April 1967, Capts Earle Boone and Dewain Vick were scheduled to fly their ninth training sortie, a night flight that included air refuelling and a Mach 2.8 run over the southern United States. During the pre-flight medical exam it was discovered that Vick had a cold that precluded him from clearing his middle ear pressure because of a swollen Eustachian tube. As a consequence, the flight surgeon grounded Dewain, and Butch Sheffield, the buddy-crew RSO, was substituted. It would turn out to be a very long night for the two fliers.

After completing air refuelling near El Paso, Texas, Earle (an experienced B-58 pilot) decided to turn after leaving the tanker to avoid a thunderstorm that lay ahead on their planned track. Earle had started a subsonic climb to perform the 'dipsy-doodle' manoeuvre to hasten the transonic breakthrough, but during the climb the fully fuelled aircraft's airspeed fell below the desired 0.90 Mach profile. To regain lost momentum, Earle lowered the nose below level flight, but when he subsequently pulled the stick back, the heavy jet shuddered in an accelerated stall. He fought hard to regain control of '966, but its angle-of-attack became uncontrollable and it suddenly entered a pitch-up rotation from which there was no recovery.

Both crewmembers ejected from the aircraft, which had broken in half and spewed a great shroud of fuel around them. Since Butch ejected first, his ejection-seat rocket ignited the fuel into a fireball, through which Earle ejected a second behind the RSO.

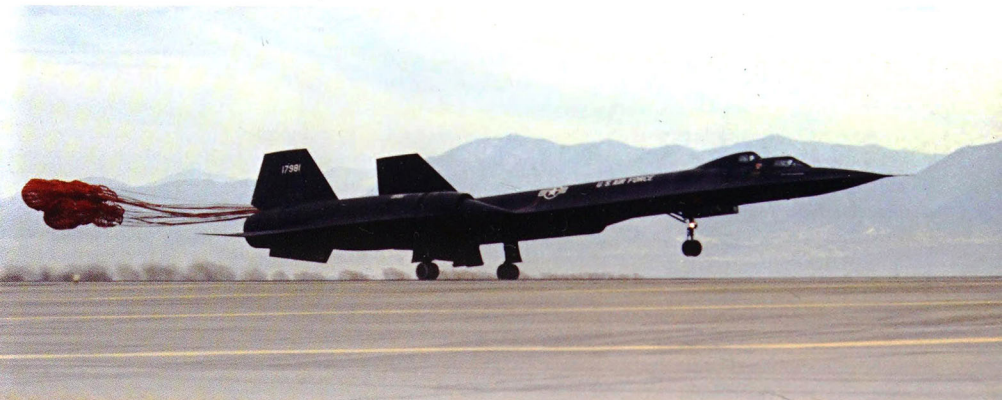
The New Mexico surface winds were gusting at up to 40kt when the pilot and RSO hit *terra firma*. Their wild ride across the desert floor ended in a cattleman's barbed-wire fence more than half a mile from initial touchdown. Neither was seriously injured, although for the next few days Earle had blisters along the back of all eight fingers, and both suffered considerable bruising and stiffness from their night parasail ride across a part of New Mexico not too far from the site of Bill Weaver's crash in '952.

A great deal was learnt from this accident, which was largely attributable to the pilot 'trying to do too much too soon' in an aircraft that was still being tested. Similar flight conditions were reflown in the SR-71 flight simulator by the other crews, and it was found that heavyweight accelerated stalls would be extremely difficult to recover from, and that secondary stalls could induce the dreaded pitch-up phenomenon, particularly at night or in clouds. SAC also began to realize that night work was being done too early in SR-71 transition training. At the same time, it was decided that all flights, including subsonic movements, should be in pressure suits for improved aircrew protection.

Eventually an automatic pitch warning (APW) system was added. This device was far superior to the original system, and following its installation no further aircraft were lost through stalls.

A serious incident that could very easily have resulted in an aircraft being lost, was experienced by Maj Bob Spencer and Capt Keith Branham on a subsequent mission, as they approached the Great Salt Lake on their return to Beale. Bob Spencer began feeling unwell, and before he was aware of the nature of his problem, he started to hyperventilate. In his reduced state of consciousness, Spencer realized that his oxygen supply had somehow been cut off, so he yanked the 'green apple' oxygen flow-starter knob on the emergency supply in his parachute's survival seat pack, which unfortunately fed into the same supply lines through which the aircraft main oxygen flowed.

Since he was high and hot, he realized that he was getting into deep trouble. The oxygen connections were located low on the right side of the ejection seat, but were out of reach. The SR-71's cockpit was pressurized to 26,000ft, which left Bob groggy and suffering from narrowed vision at a pressure altitude higher than most mountains. Now suffering from



▲ The loss of '957 created the need for another pilot trainer when '956 was undergoing major maintenance. The result was 981, a hybrid constructed from the aft section of YF-12A 60-6934 mated to the forward fuselage of a static test specimen. Serial number 61-7981 Article 2000 was referred to as an SR-71C and nicknamed 'The Bastard' due to a lack of formal documentation compared to other SR-71s. (Lockheed Martin via Tony Landis)

hypoxia, he told Keith that he was having oxygen problems and might need advice to better control a ragged descent.

At that point he reduced power and adjusted the pitch attitude on the autopilot. As the aircraft began to exceed the KEAS and Mach limits during descent, Bob grunted to open his 'gun-barrel' vision in an attempt to read the TDI instrument, which displayed Mach, KEAS and altitude. For the next ten minutes Keith shouted instructions to Bob to keep him from exceeding the dangerous low or high speed limits that could result in loss of control.

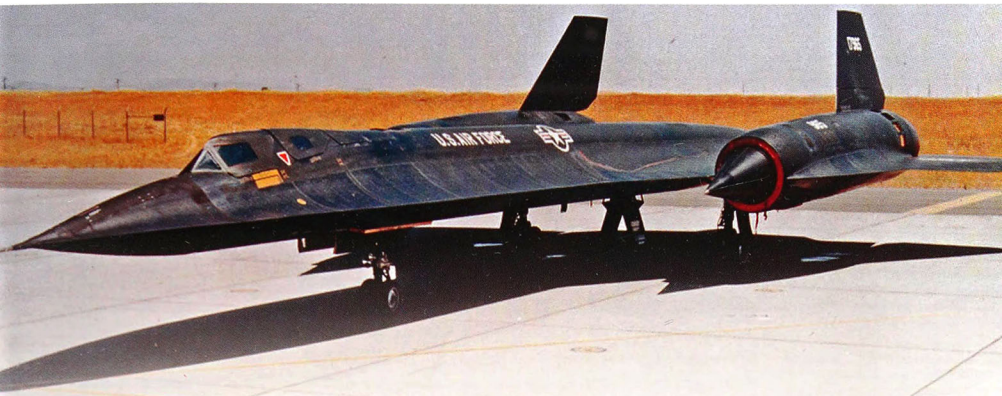
Bob and Keith brought the aircraft down to 15,000ft, where Bob snapped out of his condition, or so he thought. He 'felt so good' from the raptures of hypoxia that he convinced Keith that there was no need to divert into Hill AFB. After Keith computed that they had enough fuel to reach Beale at Mach 0.90, Bob headed for California. Halfway home, the right engine flamed out. Bob looked at the fuel pressure warning light, which had not illuminated, indicating that the flameout was not due to fuel mismanagement. He tried unsuccessfully to restart the engine, which left them in a less fuel-efficient condition since the rate of fuel use on one engine was much higher than normal.

They called the Beale command post, where the controller ordered a tanker to be scrambled to meet them over Nevada. Twenty-five minutes later, the tanker approached the rendezvous point, but initiated the 180° join-up turn much too late, and Bob and Keith saw their much-needed supply of JP-7 fly straight past them. To rejoin with the tanker, which was now well in trail, would use even more of their precious fuel, and they couldn't risk this. Luck, however, was on their side, and they recovered into Beale with very little fuel aboard.

The next day Bob and Keith listened to the voice recording and examined the read out from their MRS. In his hypoxic state, Bob had been left disbelieving of the predicament they faced, and he was stunned to hear his voice recordings. He realized how the lack of oxygen had made his responses sound absurd and he began to wonder if the flameout had also been self-induced due to his mismanagement. That flight was a stark lesson in the dangers of hypoxia. The aeroplane's oxygen system was quickly modified so the primary and emergency oxygen supplies were independently routed.

▼ Major Roy St Martin (seen here being awarded his Mach 3 tie pin by Col Charlie Minter) and his RSO Captain John Carnochan ejected safely from '965 following an INS platform failure at night. (USAF via Col Don Walbrecht)

Russ Scott, a fighter pilot who had been an Air Force Test Pilot School graduate and a Gemini astronaut candidate prior to being eliminated due to his excessive height, became impatient with the slow progression of SR-71 pilot checkouts and requested a move to the remnant A-12/F-12 programme. After an Oxcart checkout, he flew the YF-12 briefly, then joined Ling-Temco-Vought as an A-7 production test pilot. Later he was chief test pilot on Northrop's F-20 Tigershark.



▲ SR-71A 61-7965 was the second Beale SR-71A lost in an accident. (Lockheed Martin via Tony Landis)

His departure from Beale in 1966 altered the crew line-up. John Storrie was then teamed up with 'Coz' Mallozzi, since they had flown together in B-58s. Dave Dempster 'inherited' Jim Watkins, a pilot recruited from Beale's 903rd ARS, flying KC-135Qs, into the 1st SRS staff as ops officer; Watkins had all the security clearances required by the Oxcart programme. Due to his progressing years, master joke-teller Jim took a lot of good-natured ribbing from his younger squadron colleagues, occasionally wearing a World War II leather flying helmet to reinforce the 'old pilot' image.

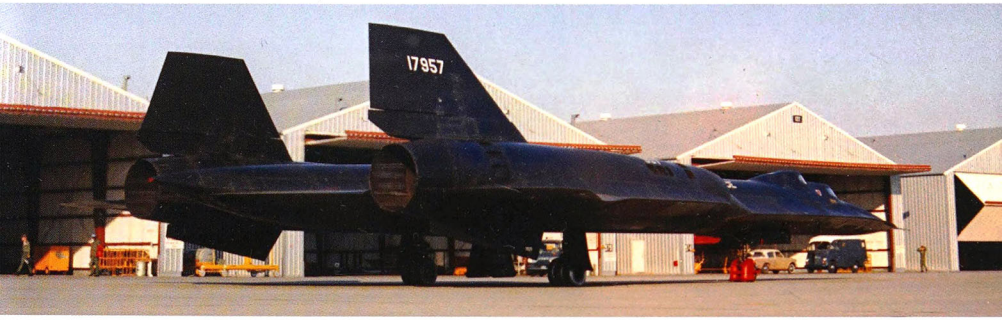
Jim Watkins and Dave Dempster flew their first SR-71 sortie together in '959 on 21 February 1967. As they progressed in their training, they flew weekly sorties, including a training sortie along the 'Kitty Three' route in '972 on 2 July 1967. The mission plan called for them to head east on a standard refuelling course across northern Nevada, accelerate east over Idaho and Wyoming, turn south to Texas, and west over New Mexico to make a photo run on San Diego, then north past San Francisco before returning to Beale.

On the eastbound leg over Wyoming their ANS failed and should have resulted in an abort of the high and hot portion of the flight and a subsonic return to base via airway routes. Since they were aware that the Senior Crown reconnaissance programme would soon be moving to cover the Vietnam War, Jim and Dave were reluctant to lose an opportunity of flying a hot leg, especially when they had the chance to attempt emergency navigation training while being backed up by the stateside VORTAC radio navigation system, which told them where they were along the route. They reasoned that should an ANS failure occur when crossing the Pacific, they would have to continue 'at speed' because of fuel considerations.

They continued to Mach 3.0 and cruise altitude using the aircraft's attitude heading reference system, its compass systems and ground-based TACAN transmissions for heading and location references. While 'whistling along' at Mach 3.0 they failed to note the precession in their magnetic compass, and when ATC at Tucson, Arizona, said: 'Aspen 21, you are now leaving the state', they did not understand the significance of the message. It was not until Dave checked their position using TACAN and the ground view-sight that he realized they had left Arizona and violated Mexican airspace. Instead of their tracking camera showing images of San Diego's harbour, it featured photographs of Ensenada, Mexico.

After a 'chewing out' by 9th SRW officials for violating the Go-No-Go checklist, they joked that they were the first to fly an SR-71 on an 'international sortie'. Before long, crews were instructed to practise a transcontinental emergency navigation leg when returning across the middle of the US.

Ten days later, Jim and Dave were airborne in '972 on a routine sortie that was typical of flights at that stage in the SR-71's development. They had climbed north from Beale into



▲ SR-71B 61-7957 was the 9th SRW's second trainer. First flown on 18 December 1965, it came to an untimely end on the approach to Beale on 11 January 1968. (Lockheed Martin via Tony Landis)

Washington and descended into Montana for refuelling. While climbing back to high altitude there was a loud bang as the left engine unstarted. The aircraft yawed hard into the dead inlet, but the SAS and autopilot kicked in right 'rudder' to maintain track.

But the unstart was so strong and the yaw angle so great that the right inlet unstarted and the engine compressor stalled. Jim fought to maintain control as '972 suffered repeated unstarts and began a descent that finally ended in stable flight at 29,000ft. When '972 returned to Beale, inlet technicians found that the linear voltage transducer within the left spike had suffered a 'hard-over' failure, and was not reacting to voltage signals from the analogue automatic inlet control system. At the time of the first unstart, the left spike had moved forward during the recapture cycle and remained extended, rendering shock wave recapture impossible. In the squadron's flight lounge, such experiences were shared as things to watch out for when flying this still-to-be-proven aircraft.

ANOTHER LOSS

On the night of 25 October 1967, a black-tie dinner was being held at the Beale Officers' Club, with Kelly Johnson as the guest of honour. At the same time, Maj Roy St Martin and Capt John Carnochan were flying a night training sortie that included a Mach 2.8 run back towards Beale.

As Roy eased '965 into the descent profile over central Nevada, the gyrostabilized reference platform for the ANS drifted without a failure warning. It provided attitude reference signals to the primary flight instruments and guidance signals to the autopilot, and its failure allowed the aircraft to enter an increasing right bank while the flight director and attitude director indicator instruments showed no deviation from wings-level flight. There was no visible horizon at high altitude over Nevada at 2025 hours in the late autumn and the few scattered ground lights merged easily with the stars as night background. An emergency reference, the miniature standby artificial horizon instrument, which used an independent gyro, was working properly, but was poorly located well down on the instrument panel, so the pilot did not note the increasing bank.

As the aircraft rolled over from its stable high-Mach run, the nose began to fall far below a safe descent angle. The SR-71 quickly plunged below 60,000ft. The crew first sensed that something was wrong when the speed increased despite the aircraft's supposedly wings-level, slightly nose down attitude as displayed on the flight instruments. At that point, Roy glanced at his standby horizon, which indicated a 'screaming dive and a roll-over toward inverted flight.' He quickly attempted a 'recovery from unusual positions manoeuvre', which had been part of normal instrument training throughout his 12 years of flying, but the nose had

progressed too low and the speed had built up to the point where the aircraft was unrecoverable, even though they were still 40,000ft above Nevada.

Although Roy had pulled the throttles to idle and rolled the wings level toward what would have been the nearest horizon, the aircraft was in a terminal dive well above the speed from which level flight could be achieved without straining '965 to the breaking point. With no options for recovery left, Roy gave the ejection order. The RSO ejected into the full force of a Mach 1.4 slipstream, from which he suffered severe strains. Just before he pulled his between-the-knees bailout ring, Roy heard a warning horn blow that indicated to him that he was below 10,000ft (with the landing gear up) and descending at a very high speed.

Tugging on his ejection ring, he escaped at a tremendous rate of descent. Exactly as programmed, his automatic escape sequence operated. The lap belt separated, the 'butt-snapper' strap in his seat tightened to fling him free of the seat, and the parachute's explosive slug fired it to full length, his canopy deploying just prior to landing at a terrain altitude above 5,000ft. While the ejection sequence was occurring, '965 plunged into the ground near Lovelock, Nevada, like a hypervelocity meteorite, creating a ring crater at its point of impact. In a blinding flash, almost all traces of the aircraft disappeared deep into the ground.

Both crewmembers survived without permanent injury, although John was grounded for a year as a result of severe concussion. Roy remembered walking for what seemed like the rest of the night towards the crash site. Meanwhile, Beale's formal dinner had been disrupted with the discovery that Roy and John were missing somewhere over Nevada. Reports soon came in from Oakland Center and Lovelock that an aircraft had crashed. A search effort was quickly mounted and the crew recovered at first light.

The accident board established that pilot error was not a factor in the loss of '965, and recommended the following design and procedural changes: (1) warning lights be provided to show ANS failure; (2) the standby attitude indicator instrument be enlarged and placed atop the pilot's instrument panel directly below the windscreen; (3) the pilot and RSO's attitude instruments be powered by different sources; (4) the training programme contain less night flying until crews had considerably more daytime experience in the SR-71.

INCIDENTS AND LOSSES

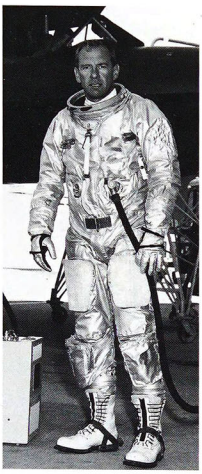
As the 9th SRW approached the time for overseas deployment, much talk in the crew lounge was devoted to anti-SAM tactics. The plan was to penetrate enemy airspace at Mach 3. If fired upon, the pilot would increase speed to Mach 3.2 and climb, thereby forcing the missile's guidance system to recalculate the intercept solutions. Some crews considered jinking options, but such manoeuvres were discounted since they would only disrupt effective intelligence gathering.

One half-baked consideration was to dump fuel to become lighter for a more rapid climb, but Watkins and Dempster ended that argument once and for all on a winter training sortie, dumping fuel for ten seconds high over Montana to see if the afterburner might ignite it. The fuel instead turned into an instant ice cloud in the -55°C stratosphere, leaving a 5-mile long contrail 'pointing' directly to the aircraft. Jim Watkins reported that he could see the trail for hundreds of miles after they had turned back towards the west.

Aircraft 61-7957, one of the two SR-71B pilot trainers, was lost on 11 January 1968. The student pilot was Capt Dave Fruehauf who was on his third SR-71B flight, having earlier completed a series of practice approaches and go-arounds on his first flight, plus air refuelling and further circuits on his second. This third flight would be his first out to Mach 3. His IP for the sortie was Lt Col 'Gray' Sowers, a highly experienced instructor and commander of the 99th SRS.

The flight had gone well and they were on the return leg to Beale when they experienced a generator failure near Spokane, Washington. This was followed just a few minutes later by a second generator failure. The crew made repeated attempts to reset both generators, which would come online briefly, only to trip again. They declared an emergency and began to decelerate and descend, levelling off at around 20,000ft. Heavy snowfall had closed virtually all possible diversion airfields, so they decided that their best bet was to reach Beale. On an extended straight-in approach, Dave lowered the gear, and as the aircraft continued to descend, recalls:

> We got to about 5 miles out and our deck angle increased as we continued to slow down to our approach speed of about 175kt. All of a sudden we lost an engine, and we just couldn't get it restarted. Within about 10 seconds the other engine flamed out. Now we're just gliding and Gray says, 'Dave, eject'.
>
> Well, I'd come from F-4s and the guy in the back always ejects first to prevent the guy in the front from getting the rocket blast from his seat. So I said 'Gray, you go'. 'No, you eject,' he replied. After I said to him a second time that he should go, he finally got kind of pissed and said 'Eject, get out!'
>
> By this time we're slowing down, and starting to get into a stall. So I said, 'Well, screw you!' and ejected and he followed. But I've always felt a little guilty about that, because my rocket blast impinged on his cockpit.



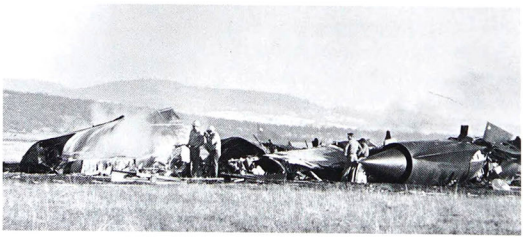
▼ When its crew ejected from just 3,000ft, 61-7957 pitched up and impacted the ground inverted. At the time of the accident, Lt Col Robert 'Gray' Sowers (above) was 99th SRS commander. (*Appeal Democrat*)

Both pilots escaped uninjured. The engines had flamed out because the fuel pumps had cavitated due to the aircraft's angle of approach, interrupting fuel flow to the engines. A subsequent accident enquiry established that the generators had dropped offline as designed when their power output began to fluctuate slightly, as this situation couldn't be tolerated by the ANS if it was to continue to provide accurate navigational information. As a result of this accident the generator trip parameters were changed, thereby ensuring that they stayed online in similar circumstances; it was felt more important to have an unserviceable ANS than no electrical power.

ONE HELLUVA FIRE

Two months later, Maj Buddy Brown and Capt Dave Jensen departed Beale in '978 to cross the Pacific to Okinawa. The 9th SRW's long-awaited deployment to the Vietnam warzone had finally begun. Meanwhile, more new crews were being trained to reach SAC's desired operational strength of two full squadrons.

On 10 October 1968, a new pilot/RSO team began its take-off roll down runway 14 at Beale, in the recently delivered '977. Maj Abe Kardong (a former B-58 pilot) was nearing the take-off Go-No-Go decision point when a wheel failed, throwing shrapnel up into the fuel cell. The afterburner flame ignited the leaking fuel, starting a fire that was catching up with the fast-moving aircraft. The buddy-crew mobile control officers warned Abe that he had 'one helluva fire', whereupon he aborted the take-off at high speed.



At that point the remaining tyres on the affected gear truck also burst; then the brake 'chute blossomed, only to be quickly consumed by fire. Abe steered the aircraft towards the

arresting barrier at the far end of the runway. But the jet crossed the rollover sensors (which triggered the arresting cable's pop-up) off-centre and with one wing low, the cable snapped up in front of an inlet, whose sharp edge instantly knifed through it.

As they proceeded on a very hard ride into the rough, the helpless RSO, Maj Jim Kogler, decided to eject. A few moments later he descended safely under a fully deployed 'chute, which had unfurled a few hundred feet up. For a brief moment he thought that he would drift back into the blazing grass fire that '977 had caused.

Meanwhile, Abe rode it out for a full half mile before the SR-71 finally ground to a halt, whereupon mobile control crewmembers Willie Lawson and Gil Martinez dashed into the blaze and extricated the pilot from the wreckage. Jim was unhurt, but Abe hobbled around for a few days from spinal compression bruising and other abrasions from his high-speed ride toward Beale's main gate.

Yet another wheel failure (fortunately the last) had resulted in the loss of an SR-71. Despite four 9th SRW aircraft losses between 13 April 1967 and 10 October 1968, Category III 'Operational' Testing ended in December 1968. The 9th SRW was awarded the Presidential Unit Citation for meeting the many great challenges that faced it as it brought the 'most advanced' reconnaissance system of its day to operational readiness.

▲ The 9th SRW suffered its fourth SR-71 loss on 10 October 1968, when 61-7977 suffered a wheel failure on take-off – a common problem early in the programme. Abe Kardong and Jim Kogler (right) had a narrow escape. (*Appeal Democrat*)

▼ During the early 1980s, the Air Force Logistics Command SR-71 flight crew consisted of (from left to right) Lt Col Tom Tilden, Lt Col B. C. Thomas and RSOs Lt Col Joe Vida and Lt Col Phil Soucy. (USAF)

CHAPTER 10

BEALE OPERATIONS

TANKERS

It's impossible to overemphasise the essential role played by the KC-135Q tanker crews, without whom successful prosecution of the SR-71 mission would have been impossible. It became apparent to SAC that the tanker force dedicated to supporting SR-71 operations would need to be expanded beyond the original 21 Q-model aircraft and in 1967 the decision was made to modify an additional 35 aircraft. Some 20 KC-135As from the 70th AREFS, 43rd BW at Little Rock AFB, Arkansas, and 15 from the 306th AREFS, 306th BW at McCoy AFB, Florida were therefore converted.

However, to save costs these aircraft weren't equipped with the full avionics suite found on the KC-135Qs stationed at Beale and were known informally as 'partial Qs'. These additional '135s lacked the AN/ARN-90 TACAN and LORAN A (the latter was subsequently removed from the Beale aircraft). Instead, these partial Qs relied upon an AN/ARC-50, known as 'Comm 3', to provide air-to-air distance measurement for the rendezvous between tanker and receiver.

◀ Beale was the SR-71's home base, where aircraft crew, support staff and their families were stationed, the so-called 'Team Recce' including the mission-critical KC-135Q fleet. Few SR-71 sorties originating from Beale were operational missions, however, the majority being training flights involving the simulator, SR-71A or B, or pilot proficiency flights in the T-38. (Lockheed Martin)

▲ The initial cadre of the 9th SRW in front of SR-71s '958 and '970, and a T-38 27 May 1967. They are from left to right: (front row) Sgt Dave Gallard, Jack Kennon, Ray Haupt, Hal Confer, Bill Haynes, Charles Minter, Harlon Hain and MSgt Loignon. The pilots in the second row are paired with their RSOs, who stand behind them in the third rank, as follows: Storrie/Mallozzi, Sowers/Sheffield, Hichew/Schmittou, Collins/Seagroves, Bill Campbell/Pennington, Halloran/Jarvis, Brown/Jensen, Dale Shelton/Boggess, O'Malley/Payne, Walbrecht/Loignon, Boone/Vick, Bevacqua/Crew, Watkins/Dempster, Devall/Shoemaker, Spehcer/Branham, McCallum/Locke, St Martin/Carnochan, Bull/McNeer, Powell/Kendrick, Daubs/Roetcisoender, Bobby Campbell/Kraus, Kardong/Coleman, Maier/Casey, Fruehauf/unknown and Hudson/Ferrell. Behind them, wearing baseball caps, are the crew chiefs, but no one has yet been able to identify them all. (USAF)

There were two types of rendezvous used by KC-135Qs during missions in support of the SR-71. Other than differences in timing, these two procedures were identical. The first, known as the 'cold' rendezvous, was used when the receiver was subsonic prior to the air refuelling, such as for the initial fuel on-load after take-off or during pilot qualification training. The 'hot' rendezvous was used when the receiver was supersonic prior to the air refuelling, which was usually the case during an operational mission or ferry flight.

The KC-135Q could simultaneously carry a maximum of 74,490lb of JP-7 and 110,000lb of JP-4 for its own engines. To account for changes in the aircraft's CG during refuelling operations, 850lb of ballast was added to the lower nose compartment. The refuelling operation was conducted at 355 Knots Indicated Airspeed (KIAS; red-line speed for the KC-135Q) and within a block altitude of FL260-270, a height lower than SR-71 crews preferred, but as high as a fully laden KC-135Q could reach while maintaining 355KIAS.

Approaching the end of the air-refuelling task, the SR-71 was at the limits of its subsonic heavy-weight performance envelope and the pilot would often engage one afterburner and cross-control the aircraft to mitigate against the effects of asymmetric thrust in order to stay in contact with the tanker. Much later in the programme, tests conducted with KC-135Rs showed a 20KIAS increase in the tanker's maximum speed, allowing the SR-71 to refuel at 375KIAS, a considerable improvement, especially during heavy-weight operations.

On 17 June 1970, Maj Buddy Brown and Maj Mort Jarvis were to fly a special mission to check out a new jammer and verify some changes that had been made to another high-powered jammer. The test was to be conducted over the Gulf of Mexico in the Eglin Test Range, which was instrumented for tracking high-altitude targets. The flight took them around the western US toward a second air refuelling near El Paso, Texas before the planned high and hot run across the Eglin Test Range. The flight, which began at 0730 hours at Beale, went well until a split-offload air refuelling from two tankers. Buddy described what happened next:

> When we completed the rendezvous, I pulled up into the pre-contact position and waited for the 'cleared for contact' call from the boomer. After receiving the call, I flew to the contact position and waited for the boom to be inserted into '970's receptacle. I got the nozzle contact light and started taking on fuel. I remember commenting to

Mort on how smooth the air was that morning; there wasn't any turbulence that one sometimes felt on the eastern side of the mountain range around the El Paso area in the summer time.

During the refuelling I was following the directional lights on the bottom of the tanker to keep position 'in the green' (the centre of the air refuelling envelope). After we'd taken on about 35,000lb of fuel, a crewman called over the boom-linked interphone that I had taken the required amount of fuel and that they would initiate a disconnect on the count of three. At the end of the count I felt the disconnect, throttled back, dropped down and back slightly and spotted my second tanker, which was to my right.

I moved to the pre-contact position behind number two, reset my refuelling system for contact and called that I was ready to refuel. The second boomer acknowledged 'ready to refuel' and I pulled into the contact position and waited for boom contact. Shortly thereafter, the boom made contact, which I again verified by feel and the 'contact-made' light on my instrument console, and continued with what I expected to be a routine air refuelling. Two or three minutes into the second refuelling, the aircraft hit a sort of bump and shook as if it had just flown through some turbulent air. I asked Mort, 'Did you feel that?,' to which he emphatically answered, 'Yes'. It felt quite unusual because the air had been so smooth that morning. It may have been another aircraft's jetwash that was laid across our track by an airliner that had passed earlier. Again, there was another disturbance that I corrected with a small stick input. Then it was quiet and smooth again.

Out of nowhere, the nose gave a small pitch down and a hard pitch up. I pushed the stick quickly forward, but the nose and canopy struck the bottom of the tanker. The nose section was gone just forward of the cockpit and the canopy had caved in on me. I thought, 'I'm inside the tanker; death is imminent!'

My next thoughts were about bailing out, so I told Mort to bail out and pulled the 'D' ring between my legs. I still thought I would eject up inside the tanker. There was a lot of noise and debris flying around as I was pushed down into my ejection seat by the rocket that was firing me free of the aircraft. Next, I was aware of free falling in my ejection seat, whose 'chute was stabilizing my descent toward 15,000ft where the butt-snapper lofted me out of my seat and my pretty parachute opened automatically. I opened my visor to look around the sky for my RSO, the Habu [SR-71] and the tanker.

The tanker was making a turn overhead and Mort was about 1,000ft below me in his 'chute. I didn't realize it at the time, but both my legs had been broken during the ejection. They were numb from the break and I couldn't feel a thing. During the descent, I looked at the ground and contemplated my landing. When I hit, I was dragged a few feet before I got one side of my parachute unhooked. I then unhooked the other side, crawled over to my seat kit and got the emergency radio out. I called the tanker and said that I was OK and asked if they had contacted my RSO. The tanker crew responded affirmative to both questions and waited for us to be picked up by a chopper from the Fort Bliss Army Hospital at El Paso, where the doctors checked us over and splinted my legs.

▼ Colonel Bill Haynes led a highly skilled team of USAF maintenance technicians as they brought the SR-71 into operational service. He chose some of the best crew chiefs and maintenance supervisors in the entire Air Force. (USAF)

▲ T-38 Talon 59-1606 was lost at Beale on 23 March 1971, when its elevator controls failed on take-off. SR-71 pilot Major Jim Hudson (left) was killed when he ejected from the aircraft too low for his parachute to fully deploy. Lt Col Jack Thornton stayed with the uncontrollable aircraft, sustaining back injuries. Hudson was the only Air Force SR-71 pilot killed on flying duties during the entire Senior Crown programme. (*Appeal Democrat*)

My aircraft had smashed into the ground approximately 20 miles east of El Paso at 0915 hours. The tanker flew back to Beale, did an inflight controllability check with an approach to landing speed and determined it was safe to make a landing. After it rolled to a stop off the Beale runway, it was encircled by fire trucks and Beale officials, who were amazed at the amount of damage inflicted to its tail, and how that tough old bird was able to continue flying with a severely damaged horizontal stabilizer.

Buddy recovered from his broken legs, was cleared to return to crew duty later that year, and served a full career as a senior staff officer.

EAGLE BAIT

During the early 1970s, an evaluation programme began involving SAC's SR-71s and Tactical Air Command's (TAC's) new F-15 fighters. Its purpose was to determine the interceptability of the SR-71 by the F-15 Eagle, which had speed and altitude characteristics similar to those of the MiG-25 "Foxbat" – the very high altitude intercept training would also be useful for the Eagle 'drivers'. The programme initially got off to a bad start with inter-command rivalries coming into play, as Buddy Brown recalls:

I was briefed on the particulars of one F-15 intercept training mission the day prior to the flight. The intercept was to take place in the Edwards Test Range area in California. We were to pass on our exact time, heading and altitude as to when we would be at a specific location over the range, to assist the intercept as much as possible, the day before the sortie. Additionally, we were to let down to 70,000ft and slow to Mach 2.85, again to assist the F-15's intercept geometry.

Just prior to our arrival at the 'start of intercept point', I was asked to dump fuel for approximately 15 seconds to mark my position in the sky. I was told that ground radar sites had got the F-15 lined up so that the pilot could make his pull-up at the right moment and 'acquire' my aircraft on his on-board radar. He called back a successful 'kill' on the SR-71. Immediately TAC Headquarters put out the word that they could shoot down an SR-71 because they had intercepted one.

Well, this did not go down well with the troops back at Beale, because they had given the F-15 guys everything they needed to make the intercept. We had not even used our DEF system to jam them. Prior to the next mission, TAC asked for the usual

information (position, altitude, speed and heading). We replied, 'We'll be in the Edwards Test Area tomorrow.' An HQ TAC staff officer protested, 'But we need the information to make the intercept.' Our reply was, 'Why? You claim you can intercept and shoot down an SR-71.' For the next two missions, the F-15 crews were unable to get anywhere near us; we didn't slow down or descend. They retracted the earlier claim, and from that point on we gave them the information they needed to ensure that the mutual training exercises were beneficial to both parties.

SUPERTANKERS AND LONG FLIGHTS

General P. K. Carlton, commander of the 15th Air Force, became interested in extending SR-71 missions to fully encompass the concept of 'global reach'. In 1970 he initiated two actions that hastened very long-range operations.

The first covered nuclear war reconnaissance. He asked his Director of Reconnaissance, Lt Col Don Walbrecht, to conceive a post-SIOP coverage of the Soviet landmass by SR-71s assisted by advanced tankers that were not yet programmed into SAC's inventory. He said, "Recce', you know that Habu: well I want a plan to help sell the Air Staff on the idea of big new tankers.' In the next few days, Don and his fellow 15th AF reconnaissance officers drew up a plan whereby the existing SIOP was covered with lots of tankers and all of the SR-71s.

After Don briefed the 'Boss' the first time, P. K. said, 'Back to the drawing boards, Recce; you're not thinking big.' A few days later, a new plan was briefed, showing that a dozen pre-positioned KC-747s and a dozen Beale-based Habus could cover all probable targets less than five hours after the initial ICBM lay-down. 'That's more like it!' he said. 'That'll help advocate the use of the Jumbos.' Soon after, newly-promoted Col Walbrecht found himself assigned to SAC Headquarters, where he was 'advocating new tankers and re-engined KC-135s' as the division chief of advanced strategic aircraft systems.

To further the cause of an advanced tanker, General Carlton stimulated a test programme that mated Boeing's modified number one 747 test airframe with an SR-71. On 6 July 1972, Merv Evenson and Coz Mallozzi flew the Palmdale test airframe '955 on a 3-hour sortie, checking out refuelling flight envelope and 'dry-boom' contact checks with the boom-equipped 747. The same day, B-52s and various fighters also took their turn in the 747 contact tests.

Throughout the 1970s, General Carlton used the 747/SR-71 recce concept, and the success of that test flight, to help promote SAC's advanced tanker programme, which eventually bore fruit in the 1980s with the purchase of 60 KC-10s. For SR-71 pilots, the KC-10 made the air-refuelling task much easier, raising the base refuelling block up to 33,000ft and the speed to Mach 0.88.

The second P. K. Carlton initiative was to prove that the SR-71 could fly longer than eight hours. In March 1971 he asked Don Walbrecht how long the Habu could fly on a maximum-effort mission. Don replied, 'About nine and a half to ten hours.' 'What's the limiting factor, TEB?' asked the general. 'No, sir,' replied Don. 'It's the liquid nitrogen used to pressurize the hot fuel tanks while flying at high Mach.' After considering the answer briefly, P. K. instructed Don to 'get with Hal Confer,' who commanded the 9th SRW at the time, and have him set up the longest sortie possible. 'Go for ten hours!'

In compliance with those instructions, Col Confer said that he would pick a tight aircraft (one with new tank sealant to reduce nitrogen leaks) and get on with it the following week. On 26 April 1971, Maj Tom Estes and Maj Dewain Vick established an endurance record for the SR-71 when they stayed aloft on multiple high-Mach legs for 10 hours and 30 minutes,

▲ Following their record-breaking long-distance flight of 26 April 1971, Tom Estes and Dewain Vick received the 1972 Harmon International Trophy. The award was made on 20 September 1971, in a ceremony at the White House. Present are (from left to right): Senator Barry Goldwater, Lt Col Tom Estes, President Richard Nixon and Lt Col Dewain Vick. (USAF)

covering a distance of 15,000 miles. The mission involved five full-up aerial refuellings and 5½ hours of Mach 3.0 time. The flight completely encircled the continental United States twice and ended with a high-Mach run around the western states. Three refuellings were done between Reno and Boise and two near Florida. The nitrogen dewers still had a little LN2 remaining and the aircraft had minimum maintenance write-ups.

Crew fatigue had been a minor problem, but Tom and Dewain were greatly inspired to make the mission a full success. Dewain recalled taking along a packet of M&M chocolates. 'Each time Tom descended for a refuelling, I'd pop my visor and quickly take on my own refuelling (a few chocolates) and quickly reseal my visor. I guess I should have contacted the Mars company for a product endorsement – M&Ms really do melt in your mouth and not in your pressure suit glove!' After 13 hours in their pressure suits, both crewmembers recalled that the UCDs also worked as advertised.

In recognition of this outstanding achievement, Tom and Dewain won the 1971 Mackay Trophy for 'the most meritorious flight of the year', and the 1972 Harmon International Trophy for the most outstanding international achievement in the art and science of aeronautics. The SR-71's 'long legs' were soon to be used in double-transatlantic sorties.

YOM KIPPUR WAR

After Israel emerged victorious from the 1967 Six Day War with Egypt, Jordan and Syria, President Sadat of Egypt planned an assault on Israel to re-establish Arab claims on former Egyptian lands beyond the Suez Canal. Syria's President Assad agreed to mount a simultaneous attack on the Jewish state from the north.

At 1400 hours on 6 October 1973 (Yom Kippur Day – the Jewish Day of Atonement), the Egyptians opened an hour-long barrage from 2,000 artillery pieces along their western border. Simultaneously, 240 Egyptian aircraft hit three Israeli airfields and other important targets in the Sinai.

Within 15 minutes the aggressors were advancing along a 130-mile front, employing five infantry divisions supported by three mechanized and two armoured divisions. As Israeli soldiers prayed in their bunkers in celebration of Yom Kippur, the Egyptian war machine rumbled over 10 pontoon bridges that had been thrown across the Suez Canal, stormed the supposedly impregnable Bar Lev Line, and established bridgeheads on the East Bank.

The Syrian phase of the attack opened simultaneously in the north, with another massive 30-minute artillery bombardment. This presaged the advance of three Syrian infantry divisions and two armoured divisions. To coincide with the advance, an independent attack was mounted by Syrian helicopter-borne commandos on the vital Israeli observation point at Mount Hermon in the Golan Heights.

The speed and ferocity of the Arab attack caught the Israelis off guard. Troops were mobilized from synagogues, and Israeli radio broke its traditional silence during Yom Kippur to broadcast instructions to its threatened population. Most Western intelligence agencies were equally surprised by the joint attack. Three days before the Arab onslaught, the Soviets had launched the low-resolution camera-equipped Cosmos 596 satellite from Plesetsk in the southwestern USSR; it allowed them to watch the battle on behalf of their Arab allies.

The Israelis regrouped within two days and attacked the bridges over the Canal. In the north, the Syrians continued their push towards the River Jordan and the Sea of Galilee. The Soviet reconnaissance effort was strengthened on 8 October when Cosmos 597 was launched; it was able to change its orbit using rockets and despite the resultant increase in the satellite's speed, the perigee improved photographic resolution. Its path, inclined 65° to the equator, aligned it across both fronts. The next day Cosmos 596 was recovered, while the ground situation had turned in favour of the Israelis.

Syrian efforts in the north had ground to a standstill after a furious battle, and Israeli General Sheron's forces in the south had successfully attacked the Egyptians and retaken a secondline fortification that had fallen the day before. The Soviets launched Cosmos 598 on 10 October to improve surveillance of the warzone. Pitched slightly higher than the preceding Cosmos satellites, 598 was already in orbit when 597 returned its film cassettes to earth. The Soviets were also receiving real-time imagery from 598 via the Yevpatoriya tracking station in the Crimea.

As a consequence of the Soviet advantage in reconnaissance, the US decided to step up its intelligence efforts. The SR-71 offered the best hot-spot reconnaissance capability, and plans were drafted to fly missions from Beale to Egypt and recover into Mildenhall. This long-range concept had been validated two years before by the Estes/Vick 15,000-mile test sortie.

General John Meyer, CINCSAC, ordered Col Pat Halloran to prepare for the missions. At that point, Pat knew the sorties would attract wide attention within government circles, and that their success would justify the Senior Crown programme. Due to its importance, he asked the new 15th Air Force commander, Lt Gen Bill Pitts, for permission to 'run the show' himself. At this early stage, the plan was to launch an SR-71 from Beale and refuel immediately after take-off before climbing and accelerating to the next ARCP near Nova Scotia, Canada. A second Mach 3 leg would terminate at a third ARCP off Portugal, before another hot leg to Crete for a fourth AR. The SR-71 would then be flown over the Israeli/Egyptian battle lines before decelerating and descending into the Crete ARCP, followed by another hot leg out of the Mediterranean to refuel again off Portugal before recovering into RAF Mildenhall, Suffolk, England, after a mission lasting 8½ hours.

Halloran put together a maintenance recovery team and left Beale on a tanker for Mildenhall at midnight on the same day as they alert was given. He later recalled:'I was scheduled to go straight to London to brief senior MoD officials on the plan, but upon my arrival at Mildenhall I was informed that the British government had had second thoughts and denied us authority to operate from the UK. I was then told that Griffiss AFB in New York State would be our operating location. Without rest we turned the tanker around, and the full complement of planners and maintenance personnel was reloaded for a quick return trip to the US. Undoubtedly that was the shortest overseas TDY in the history of the 9th Wing!'

It appeared later that the UK's Heath government had denied the Air Force use of Mildenhall so as to guarantee continued oil supplies from the Arabs, a move that would later produce heated exchanges between Europe and the US. To complicate matters still further, the Turkish government refused permission for KC-135Q tankers loaded with the SR-71's JP-7 fuel from storage tanks at Incirlik, to support the missions directly from its country. This forced SRC planners to establish a re-supply system involving tankers repositioning JP-7 from Incirlik to Torrejón, Spain, before they could refuel the Habu.

Before leaving Beale, Col Halloran had instructed Lt Col Jim Shelton and his RSO Lt Col Gary Coleman that as the Standard Board (stan/eval) crew they would fly the first sortie. After learning the outline details of the mission and the scheduled take-off time, Jim Shelton had a Seconal sleeping tablet and went to bed that afternoon to ensure he was rested.

▲ Colonel Pat Halloran headed the SR-71 detachment at Griffiss AFB, New York. Air Force Logistics Command deployed '955 to Griffiss under the code name Black Knight, ostensibly to evaluate a new DEF system. The exercise provided a useful cover story for a series of 11-hour transatlantic round-robin missions over the Middle East. (Tom Pugh)

During the course of the early evening briefing, Jim recalls being told by the intelligence officer, 'Now don't be surprised if the Israelis or the Egyptians shoot at you because we haven't told anybody you're coming.' It was about midway through the weather briefing that the crew were told that the mission had been cancelled due to the stance taken by the British government.

However, back at the Pentagon, former SR-71 RSO, now SR-71 Program Element Monitor (PEM), Lt Col Ronnie Rice interceded, knowing that Palmdale's flight test SR-71 ('955) was scheduled to conduct a series of evaluations on its new A-2 DEF systems from Griffiss and that rail tankers containing JP-7 to support the test had already been positioned in a siding near the base. The decision was therefore made to base the mission in New York state and fly a round-robin sortie lasting 11 hours 20 minutes. This also had the added advantage of additional support being available from Lockheed's technical field support personnel, and a ready-made cover story for the secret operations over the Middle East.

As Col Halloran and his advanced guard set course from the UK back to the US seaboard, Jim Shelton and Gary Coleman were told to go and get some crew rest ready for the long mission scheduled for the next day. Unfortunately this wasn't an instruction that Jim was able to comply with, since he was now wide awake after his earlier Seconal-induced sleep. With the amended plan now approved by SAC HQ, Lt Col Jim Shelton and Maj Gary Coleman got airborne from Beale in '979 late on the afternoon of 11 October. Jim recalls:

> As we were told this was a priority mission, the planners had drawn a straight line from the end of our Nevada air-refuelling track straight to the holding fix at Griffiss, not bypassing any of the big towns. It was a clear night and I remember seeing Chicago out of the left window and Indianapolis out of the right. And I said to Gary, 'We're really creating a sonic boom' – as we transited the country at Mach 3!
>
> So we arrive at the holding fix and I'm going through the checklist as we're getting ready to land, about 10 miles out I extended the landing gear and turned on the landing light. But just as I start my flare I said to Gary, 'Oops, the landing light has just burned out.' So I turned on the little taxi light instead. Anyway, when we get out of the aircraft, the base commander is there and he said, 'SAC told me this was a big hush-hush secret mission. You didn't even turn your landing light on until you were over the runway.' I didn't like to tell him that it had burned out and that what he saw was our taxi light!'

Once on the ground, Jim made a call to Al Joersz and John Fuller (who would fly a second SR-71 into Griffiss) and advised them to make their descent profile over the Great Lakes to minimize the effects of the boom on the urban eastern states, since there had been a number of public complaints. Fortunately, there were no boom reports when the second crew made their crossing. The next day's newspapers reported a strange phenomenon, which was described by one scientist as a probable 'meteoric shock wave'.

Jim continues: 'The Lockheed maintenance folks took our airplane and parked it at the end of a large hangar. Unfortunately, as they were backing Al's plane in, they didn't have the hangar doors open enough, and it hit the wing tip. So until a new wing tip arrived we didn't have a back-up aircraft.' An hour after the second SR-71 landed, the first tanker arrived, carrying Tom Estes (the operations officer), three mission planners and a number of Beale's best intelligence and maintenance personnel. At 0600 hours a secure teleprinter clattered out the final details of the first sortie, which was to be flown 22 hours later.

The first major question to arise when the aircrew met with the mission planners concerned diversionary fields, and no one could offer a satisfactory answer. Later that morning, the Mildenhall tanker arrived, and the unit's technicians began preparing '979 for the longest operational sortie to date. By mid-afternoon someone suggested that the crew should get some sleep, since they had been up for nearly 36 hours and would soon be airborne for another 16 hours during the sortie itself.

Jim went to see the base's flight surgeon for another Seconal tablet, which he finally managed to get after some considerable persuasion. The two were directed to an old bachelor officers' quarters (BOQ), where their room was hot and the beds uncomfortable. Gary Coleman recalled, 'No one could snore like Jim Shelton and I got no sleep at all, but I consoled myself with the thought that my pilot was getting some solid rest!'

For this vital mission, the aircraft was equipped with an optical bar camera in the nose section and two Tech cameras, one in the left, the other in the right chine. The stubbornness of usually helpful allies was causing a real headache, requiring the tanker crews to pre-position JP-7 fuel from Mildenhall and Incirlik to Torrejón in Spain, and the quest for emergency landing sites was proving all but impossible.

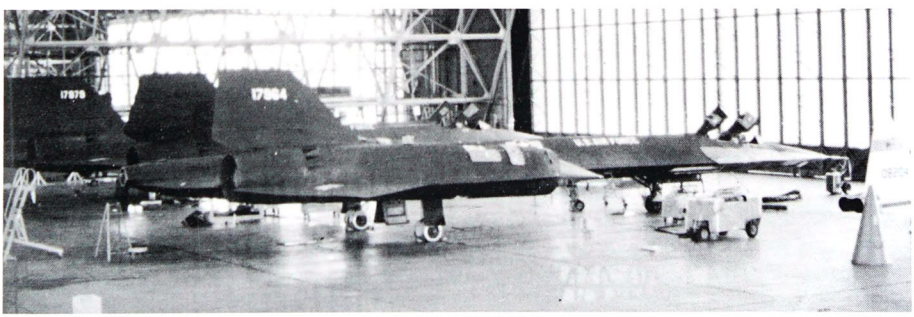
Notwithstanding, Jim Shelton cranked '979's engines on cue and lifted off from Griffiss at 0200hrs on the first of nine Giant Reach/Busy Pilot missions. He made good the first of six aerial refuellings (two tankers in each AR track) off the Gulf of St Lawrence (Old Barge East). He recalls, 'Over Nova Scotia it was quite warm and turbulent; I hooked up to the tanker and as I started to get heavy the stick-shaker came on a couple of times.'

Having topped off, '979 accelerated and climbed east en route to the next cell of tankers off the coast of Portugal (Rota East). Returning again to speed and altitude, the Habu made a high-Mach dash through the Straits of Gibraltar and let down for a third AR south of Crete (Crete East). Due to its proximity to the warzone and Libya, the US Navy provided a combat air patrol (CAP) with carrier-based aircraft on station in the Mediterranean.

Climbing and accelerating again, the crew coasted in over Port Said. Gary Coleman comments: 'There was no indication of anything launched against us, but everyone was painting us on their radars as we made our turn inbound. The DEF panel lit up like a pin-ball machine and I said to Jim, "This should be interesting".' Jim recalls: 'We lost the lights [ECM warning lights] as we went down south of Cairo and we turned around and came back across the battle area again, making a big "X" over the Sinai. I saw some contrails below me, but I couldn't tell if they were Egyptian or Israeli fighters.'

In all, '979 spent 25 minutes over denied territory. Entering Egyptian airspace at 1103 GMT, it covered the Israeli battlefronts with both Egypt and Syria before coasting out and letting down for the fourth ARCP (Crete West), which was still being CAPped by the US

▼ Aircraft '979 and '964 in a hangar at Griffiss. T-38 Talon Toxon 01, just to the right, was chase for the subsonic phase of '955's DEF test flights out of the base. (Tom Pugh)



Navy. The next hot leg was punctuated by a fifth refuelling, again off Portugal (Rota West), but the tankers from Torrejón had difficulty getting clearance through the busy airliner-filled offshore airway and only just arrived at the ARCP ahead of the Habu. They could not request a priority clearance because of the secrecy of their mission. When approval was at last received, the air traffic controllers hesitated clearing the tanker cell on its requested track because 'unidentified high speed traffic, height unknown', was approaching from its 12 o'clock position. The tankers could not reveal that the traffic was actually their trade.

Jim recalls that since this was going to be such a long flight, he'd try tube-food for the first time. He said:

> The stuff comes in what looks like a large tube of toothpaste – I decided I'd try the apricot flavour. You had to take the cap off and then screw this other cap on the tube that went through the feed port of your helmet. But of course this stuff is filled at sea level and our cockpit is pressurized at 26,000ft, so there's quite a difference in pressurization. So when I break the tube, about a third of the apricot spews out and I'm trying to put it in my pocket so it doesn't go everywhere in the cockpit!
>
> The other thing I had to worry about during that flight was urine collection capability. We had a little plastic bag that fitted into the pocket of your pressure suit and there was a sponge in it to help it absorb the fluid. Well I had three or four of those, and the first one's fine, you just put it in your right pocket, because your left one is where your current device is. So what do you do with the third one? I used the canopy emergency ejection handle to my left. I found I could tie the bag there and there was nothing that could poke it, but every time I lowered my seat to refuel I had to put my hand on it to be sure it was clear, then do the same after the AR when I raised my seat – I certainly didn't want to put a hole in it and leak urine all over the cockpit floor!

Soon after completing his mid-ocean refuelling, Jim climbed and accelerated '979 back up for his final high-speed run across the western Atlantic towards New York. Mindful of his own fatigue, Gary was in awe of his pilot, who completed a text book sixth air refuelling (Old Barge West). Jim finally put '979 back down at Griffiss after a combat sortie lasting 11 hours 13 minutes (more than five hours of which was at Mach 3 or above)

The demanding mission had required support from 14 KC-135Qs, four from Goose Bay, two from Griffiss and eight from Torrejón. Two of the Goose Bay tankers recovered directly into Loring AFB, Maine. The two that had refuelled the mission aircraft over the Gulf of St Lawrence on the first leg flew to Little Rock AFB, Arkansas to take on additional JP-7 before flying to Loring for further staging. Six of the Torrejón-based tankers flew to Incirlik after refuelling the SR-71 and uploaded JP-7 before returning to the Spanish base.

The reconnaissance take was of high quality and provided intelligence and defence analysts with much-needed information concerning the disposition of Arab forces (and Soviet equipment) in the region, which was then made available to the Israelis.

The Syrian military situation was swinging in favour of the Israelis by 14 October. The Soviets had stepped up their airlift of military equipment, but were aware that the Syrian front was collapsing. Washington had begun supporting Israel with a huge airlift of US war materiel. President Nixon had requested $2.2 billion in emergency aid for the Israelis, a request that incensed Abu Dhabi, Libya and Qatar, which had been meeting with oil companies in Vienna since 12 October. They immediately imposed a complete oil embargo on the US, a move quickly followed by the other OPEC oil producers. To further warn nations against supporting Israel, they unilaterally announced a 70 per cent rise in oil prices and a 5 per cent per month

cut in petroleum production. The decision caused panic in Western Europe, which depended on the Arab states for 80 per cent of its oil supply.

Meanwhile, in the Sinai desert the Egyptians launched a 100,000-strong offensive toward the east on 14 October, resulting in one of the largest tank battles in history. As Israeli forces gained ground, they also established a bridgehead west of the Suez Canal that threatened to cut off the Egyptian army. With the Egyptian military situation becoming more and more acute, President Nixon announced that US forces across the globe had been placed on military alert following the receipt of information indicating that the Soviet Union was planning 'to send a very substantial force to the Middle East to relieve the beleaguered Egyptian Third Army, now completely encircled in the Sinai.' This tense period in superpower relations was somewhat defused when Soviet Secretary Brezhnev supported a United Nations motion of 24 October that would eventually end the Yom Kippur War.

Meanwhile, SR-71 surveillance missions continued. At 0200 hours on 25 October, Maj Al Joersz and Maj John Fuller got airborne from Griffiss in '979 and paid a second successful visit to the Yom Kippur war zone, although after protests from the Spanish government, the second and fifth AR tracks were repositioned off the coast of the Azores (out of range of Spanish radars) and renamed Lajes East and Lajes West. Since the US intelligence community was concerned that the Soviet Union might deploy more personnel and materiel to the Arabs, the mission's priority objectives were to monitor port facilities at Latakia and Tartus in Syria, and Port Said and Alexandria in Egypt.

▲ Lt Col Jim Shelton and Lt Col Gary Coleman completed the first round-robin mission from Griffiss over the warring Middle East factions. Jim is seen here earlier in his SR-71 career. (Jim Shelton)

Additional mission objectives were to determine the extent of the Israeli thrust across the canal and confirm the precise location of the Israeli, Egyptian and Syrian fronts. The SR-71 was therefore required to photograph an area 20nm west and 10nm east of the Suez Canal.

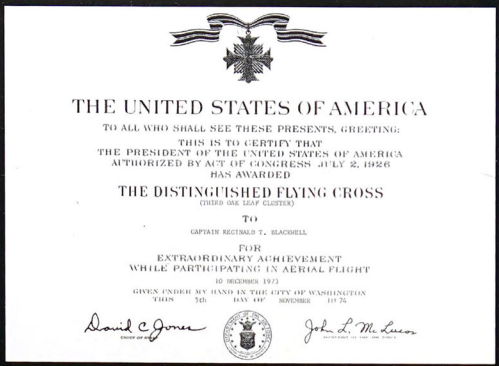
Sixteen KC-135Qs supported this second mission. The first and last ARCPs were moved from the Gulf of St Lawrence to an area south of Nova Scotia and covered by four tankers re-deployed from Griffiss to Loring.

A third mission, scheduled for 2 November, was postponed due to poor weather over the target area and instead flown, again by '979, on the 4th. Maj Bob Helt and Maj Larry Elliott secured more photography of the ports for national intelligence users, and also covered Cairo international airport and the Tura cave facilities near Cairo, which, it was believed, might contain Soviet "Scud-B" mobile missiles. The mission lasted nine minutes longer than the previous two, establishing an SR-71 endurance record of 11 hours 22 minutes.

Maj Jim Wilson and Maj Bruce Douglas took '964 on its first sortie to the Mediterranean on 11 November. The 10-hour 49-minute flight departed Griffiss and terminated as planned at Seymour Johnson AFB, North Carolina. The reason behind the detachment migration to the south was to avoid the New York winter weather. Col Don Walbrecht headed the new detachment, which had been pre-arranged with HQ TAC by Col Harlan Hain from the SAC Reconnaissance Center.

Of the four KC-135Qs at Loring, two supported the SR-71 in the first air-refuelling track before recovering back. Three then departed to join the 13 Q-birds at Torrejón, while the fourth flew to Griffiss, picked up maintenance and staff personnel, then positioned them to Seymour-Johnson AFB.

To enable more timely analysis of the mission data, SAC received authority from Headquarters USAF to move portions of the SR-71 Mobile Process Center from Beale to Seymour Johnson, a task accomplished with the assistance of a C-5A and a C-141 on 12 November. It was operational just 92 hours later. The move reduced the number of air-



THE UNITED STATES OF AMERICA

TO ALL WHO SHALL SEE THESE PRESENTS, GREETING:

THIS IS TO CERTIFY THAT
THE PRESIDENT OF THE UNITED STATES OF AMERICA
AUTHORIZED BY ACT OF CONGRESS JULY 2, 1926
HAS AWARDED

THE DISTINGUISHED FLYING CROSS
(THIRD OAK LEAF CLUSTER)

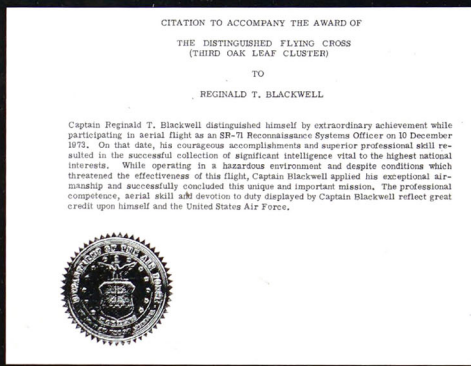
TO

CAPTAIN REGINALD T. BLACKWELL

FOR
EXTRAORDINARY ACHIEVEMENT
WHILE PARTICIPATING IN AERIAL FLIGHT
10 DECEMBER 1973

GIVEN UNDER MY HAND IN THE CITY OF WASHINGTON
THIS 5th DAY OF NOVEMBER 19 74

David C. Jones — John L. McLucas



CITATION TO ACCOMPANY THE AWARD OF

THE DISTINGUISHED FLYING CROSS
(THIRD OAK LEAF CLUSTER)

TO

REGINALD T. BLACKWELL

Captain Reginald T. Blackwell distinguished himself by extraordinary achievement while participating in aerial flight as an SR-71 Reconnaissance Systems Officer on 10 December 1973. On that date, his courageous accomplishments and superior professional skill resulted in the successful collection of significant intelligence vital to the highest national interests. While operating in a hazardous environment and despite conditions which threatened the effectiveness of this flight, Captain Blackwell applied his exceptional airmanship and successfully concluded this unique and important mission. The professional competence, aerial skill and devotion to duty displayed by Captain Blackwell reflect great credit upon himself and the United States Air Force.

▲ Reg Blackwell was awarded the DFC for his part in the reconnaissance mission flown over the Golan Heights on 10 December 1973. (Reg Blackwell)

refuelling tracks from six to five, despite the distance being much the same. In fact, the more southerly base enabled the SR-71 to cruise longer at supersonic speed on its return to the US, rendering it more fuel efficient.

Since the shooting war was over, SR-71 reconnaissance was now used to demonstrate compliance with the ceasefire agreement and provide irrefutable evidence for Secretary of State Kissinger's team, which was leading the delicately balanced withdrawal negotiations between the deeply distrusting Israelis and Arabs.

Fierce fighting broke out along the ceasefire line on 30 November and threatened to destroy the fragile agreement brokered by the US. Jim Sullivan and Noel Widdifield flew '964 across the Atlantic on 2 December to look at the situation. It proved to be a well-timed move, since fighting had begun that same day in the Golan Heights. Further diplomatic pressures put an end to the new skirmishes before Pat Bledsoe and Reg Blackwell went out in '979 on 10 December for another look at the belligerents. They flew a 'clockwork' 10-hour mission, arriving back at Seymour Johnson 'on the minute' of their flight plan. Things were quiet for the next five weeks, so the Beale troops went home for Christmas. In January they returned to base to carry on with Sinai surveillance activities.

On 25 January, Maj Buck Adams and Maj Bill Machorek flew another perfect 10-hour sortie, but they returned to Seymour to face a very low ceiling and visibility that mandated a diversion to Griffiss. This would put the take out of position for processing. Don Walbrecht said: 'We had Buck grab some fuel from the standby tanker and "jacked the ceiling up a bit" (against the complaints of Harlon Hain at SAC Headquarters) and Buck snuck in to a perfect landing at Seymour under the lowest ceiling an SR-71 has ever landed.'

The detachment's spirited 'high jinks' (after each outstanding mission of recognized national importance) annoyed the 4th Fighter Wing Commander, Col Len Russell, whose fuel stocks had been quickly depleted by the five KC-135Q tankers that supported the SR-71 movements. With a serious shortage of fuel throughout the war, Seymour Johnson had not been resupplied for fighter training sorties. To further complicate matters, Beale's new 14th Air Division commander, Brig Gen Don Pittman, really messed things up by demeaning Col Russell, who was embittered by what had appeared to be SAC 'heavy-handedness'. The fuel embargo imposed by the OPEC nations caused the Air Force to

▲ Colonel Pat Halloran was the initial detachment commander when the SR-71 deployed to Seymour-Johnson AFB, North Carolina, in 1974. Col Don Walbrecht soon took over command, however. The aircraft flew missions from the base during the Yom Kippur War. (USAF)

husband its fuel supply and drastically reduce other flying to currency rides only. Because of Russell's complaints to his TAC boss Gen Dixon, headquarter's arbitration was necessary to put things back in perspective. SAC's Deputy Chief of Staff for Logistics came to Seymour Johnson to thank Russell for supporting the Sinai effort and to solve his fuel problem. Within a few days, the pipeline flowed with JP-5 for the TAC F-4s and a trainload of JP-7 arrived for the two SR-71s.

The success of international peace efforts soon began to show. On 18 January 1974 a military separation agreement was signed between Egyptian and Israeli defence officials that led to troop withdrawals. By mid-February, the Middle East peace process was beginning to go into 'overdrive' and on the 18th, four Arab nations proposed a truce in the Golan Heights.

To verify the pull back, '971 was dispatched to the Suez on 25 January. There had been a great deal of suspicion on both sides that the opposing forces would not pull back; the Habu's photography became the instrument of verification and was shown at the peace negotiations as proof. With the evidence in hand, full diplomatic ties were finally restored between Egypt and the US after a break lasting seven years.

As troop withdrawals continued, Maj T. Y. Judkin and Maj G. T. Morgan flew '979 on the next to last long sortie. Appropriately, this apparently evergreen aircraft also flew the final sortie on 6 April 1974. It had flown two-thirds of the nine '10-hour' sorties, chalking up a remarkable rate of success despite their very demanding nature, without ground or air aborts or diversions.

Those nine long flights represented a pinnacle of operational professionalism. They were a tribute not only to the dedication of the aircrews, but also to that of the staff planners and the small group of top ground technicians who maintained the SR-71s away from home. These sorties also stood as a testament to the long reach of the aircraft and its ability to operate with impunity in a high-threat environment.

However, they placed considerable strain on existing SR-71 operations, especially since Headquarters USAF had decided to cut the number of primary authorized aircraft (PAA) from eight to six with effect from 1 July 1973. The JCS therefore tasked the SRC to undertake an evaluation of Senior Crown's overall operational effectiveness. The SRC concluded that the Mediterranean photo-reconnaissance mission had: 'Severely degraded the ability of the 9th SRW to maintain currency and crew proficiency for non-combat ready crews.'

As a result, on 12 January 1974, the Secretary of Defense gave formal approval to restore the number of PAA SR-71s back to eight A models with effect from 1 July. Consequently, '976 and '975, which had been in storage at Beale, were returned to operational status. Aircraft '975 was positioned to Lockheed Palmdale and refurbished prior to becoming the functional flight test aircraft for the prototype Defensive H ECM system that was in development. To support the enlarged fleet, nine more officers and 64 additional enlisted personnel were recruited into the programme.

SIMULATOR TESTS

Capt Maury Rosenberg and another Air Force pilot were instructed to report to the General Dynamics plant at Carswell AFB near Fort Worth, Texas, in May 1976 to help in some research. The two officers were directed to an obscure room in the plant containing two very crude cockpits equipped with a stick, throttles and basic flight instruments. The room was a web of electrical wiring connected to racks of monitoring apparatus and a computer. The aircraft's 'capability' was Mach 3.0 at 100,000ft with no simulated armament. The other cockpit was similar, but it also had a radar, a fire-control panel and 'carried' missiles.

Two basic intercept profiles were flown. The first began with the missile-equipped interceptor scrambled from an alert pad when the unarmed 'aircraft' was detected 350nm away, and a repeat was flown when the target was 450nm away. In the second profile, the missile-equipped aircraft was in an airborne race track pattern. As the unarmed aircraft entered the area, the interceptor was vectored inbound on various intercept angles – head-on, abeam and tailchase.

Four engineers monitored readouts as the scenarios were played out and would stop the proceedings to reset their instrumentation when they changed from one vector to another. It was dull, time-consuming work in which only 12 intercepts were to be completed in a full day. The engineers asked the pilots lots of performance questions to help verify some relevant flight data that they already gleaned from another source. It did not take long to abandon the scramble profile and concentrate on an orbit-vector profile. Pat Bledsoe repeated those 'simulator flights' two weeks later. One of the other pilots involved in the tests was Maj Bob McConnell, who later became an air attaché in Moscow.

Soviet pilot Viktor Belenko defected from Siberia to Japan four months later in a MiG-25P. During his CIA debriefing, he talked about how he was trained to shoot down an SR-71 near Vladivostok, and how the Soviet controllers and pilots had reached the conclusion that their best chance to make an intercept would be achieved by being airborne in a holding pattern that faced the track of the high flyer. He admitted that experience against other "Foxbats" showed that the prospect of getting an SR-71 was quite remote, unless one carried a 'nuke' intercept missile.

▼ This group shot was taken after Lt Col Roger Jacks' last SR-71 flight. From left to right (top row) the crewmembers are: John Murphy, Joe Vida, Don Emmons, Al Cirino, Tom Alison, John Fuller, Rich Graham, Buz Carpenter, Bill Groninger and Bruce Liebman. Standing at the left are Bill Keller, Chuck Sober, Joe Kinego (in the pressure suit to the left), and Roger Jacks. In the bottom row are Jim Sullivan, Jay Reid and Tom Keck. Standing to the right are Bredette 'BC' Thomas, Anthony 'Pat' Bledsoe (almost obscured) and John Storrie, the 9th SRW commander. (USAF)

RECORDS

In 1976 SAC and HQ USAF agreed to show some of the SR-71's capabilities as part of the nation's bicentennial celebrations. The original plan was to set an 'around the world at the equator' speed record. Pat Bledsoe and John Fuller were the senior crew at that time and were chosen to make the flight. Initial planning showed that it could be done in 16 hours and 20 minutes with seven refuellings. The only modification required for the SR-71 would have been an additional liquid nitrogen dewar for fuel-tank pressurization.

The crew were sceptical of their own physical limitations for a flight of that duration, but believed that adrenalin would probably keep them going. Pat recalled: 'Preparations proceeded well until the full plan reached HQ USAF. When the generals saw the cost of deploying the fuel and tankers to forward bases they were aghast. It would take nearly 100 KC-135 flights to carry out the operation safely. The word came back to Beale to "do something more reasonable".' Consequently, the 9th set a new series of world speed and altitude records on 27 and 28 July 1976. (See Appendix 9)

THE FALKLANDS

Argentina invaded and captured the Falkland Islands on 2 April 1982. Three days later, a Royal Navy task force set sail from Portsmouth with the objective of driving the invaders out and returning the islands to British rule. Twenty days later, Royal Marine commandos recaptured South Georgia island and soon after, President Reagan pledged American support to Britain. He branded the Argentinians 'aggressors' and ordered economic sanctions against them. He also offered to supply Britain with 'unspecified' war materiels to assist in the recapture.

Seventy-three days after the invasion, British troops completed their objective and the Union Jack flew over the Falklands once again. Did the SR-71 fly over the islands during the conflict? An analysis of the problem took place at the Pentagon. The study showed that SR-71s could have covered the area easily if SAC could operate KC-135s from South American bases: this, however, was politically unacceptable. It was too difficult to operate the KC-135s exclusively from the US because they could not take on fuel in flight. KC-10s were not available to buddy refuel the tankers far enough, so the idea was dropped and the task was left to other sensors.

GIANT PLATE AND CLIPPER SORTIES

The origins of US high-altitude surveillance of Cuba can be traced back to 1962 and the now infamous missile crisis. SAC U-2s continued to regularly monitor the island, located just 90 miles from the southern tip of Florida, until the task was passed to the SR-71 in September 1974. The reason behind the move was the sheer number of commitments undertaken by the U-2 fleet throughout the world, which had recently increased still further to include monitoring the Middle East from the Mediterranean island of Cyprus after the Yom Kippur War.

Headquarters SAC had, as far back as 1 July 1970, prepared a contingency plan for such an event, code named Giant Plate. The primary objective of these sorties was to collect Photint, and about 90 per cent of the Cuban landmass was photographed on every mission. However, unlike other SR-71 sorties, it was the JCS that decided when such a sortie would be

launched rather than the SRC. For planning purposes, the JCS initially directed SAC to prepare for such a sortie once every 30 to 40 days, but through 1975 and 1976, the Giant Plate mission rate averaged out at only one every 55 days.

To conduct these round-robin sorties from Beale it was necessary for the SR-71 to undertake three air refuellings (six different tracks had been established in the Caribbean area for this task). A typical mission lasted about 5.5 hours, of which around 50 minutes was spent in the collection area. Of particular interest to the JCS was the deployment of any new weaponry from either the Soviet Union or Eastern Europe, and the monitoring of the Soviet naval task forces that regularly visited the island. Each Giant Plate sortie was carefully monitored and tracked on radar by the Cubans; as a consequence, the SRC varied the aircraft's track on every mission. The first sortie took place on 26 September 1974 and the aircraft was crewed by Maj Lee Ransom and his RSO Maj Al Payne.

In response to a significant adjustment in United States foreign policy made towards Cuba in early 1977 by President Jimmy Carter, the JCS directed Headquarters SAC to end all Giant Plate overflights. As a consequence, on 11 January 1977 the last planned sortie in a series of 18 missions was completed by Capt Maury Rosenberg and the same RSO that had conducted the first, Maj Al Payne. Unfortunately for the crew and photo interpreters, the western half of the island was blanketed by heavy cloud. In addition, the OBC's film guidance rollers became loose in their mounts, damaging what little imagery that had been clear of cloud.

Despite the Carter administration's best intentions, it soon transpired that in spite of earlier conciliatory rhetoric, Castro had actually accelerated Cuba's export of Marxist revolution to several developing nations in Central America, Latin America and Africa. By the summer of 1978, US State Department estimates believed that there were no less than 40,000 Cuban soldiers and civilians in 14 African countries. Later that same year a reconnaissance satellite photographed a Soviet freighter in Havana harbour, surrounded by large crates that were being moved to a nearby air base where aircraft were being reassembled.

It appeared that 15 MiG-23s had been supplied to Castro's air force. Such an upgrading of Cuban air strength was worrying. The MiG-23BN "Flogger-H" was known to be capable of carrying nuclear weapons and if it was indeed this variant of the MiG that had been exported, then the shipment violated the 1962 Kennedy-Khrushchev accord, in which the Soviets had pledged not to deploy offensive weaponry on Cuba.

▼ The KC-135Q navigator was key to the tanker initiating its turn perfectly, thereby ensuring that the SR-71 'receiver' arrived in close trail. Note the grease pencil call signs. Blown 72 and 73 are tankers and Aspin 31 the SR-71 (Aspin 30 was always the SR-71B call sign, while Aspin 31, 32, etc were used by SR-71As). (Paul F. Crickmore)

A decision was therefore made in November 1978 to fly SR-71s over Cuba to identify the MiG variant – the first mission was flown on 12 November. A lack of surveillance of the island over the intervening 22 months generated an enormous list of targets from national intelligence users, much of which was aimed at proving compliance with the earlier accord by establishing the absence of weapon systems that would constitute a violation by the Castro regime.

On 20 November, President Carter said that the Soviet Union had assured him both publicly

and privately that the MiG-23 jets were in Cuba for defensive purposes only. A *Pravda* commentary citing the American press said 'the presence of such aircraft would run counter to the 1962 agreement'. It went on to say that the MiG reports 'were groundless and a provocation from beginning to end'. Photographs taken by the SR-71 confirmed the Soviet claims – the aircraft were indeed MiG-23MS "Flogger-Es", optimized for the air defence role.

On 1 December 1978, amid concerns that the classified mission codename Giant Plate had been compromised, SAC HQ assigned a new one, Giant Clipper, to Fragmentary (Frag) Order 60-FY-14-01, which governed the execution of all SR-71 Cuban reconnaissance missions.

Nonetheless, Bellicose statement's and the reported presence of a Russian brigade, did nothing to reduce US concerns over Cuban intentions in the area and threatened the Senate's ratification of the Strategic Arms Limitation Treaty. As a result, the 12 November mission actually set a precedent for flying further SR-71 monitoring sorties over the island and resulted in the JCS directing SAC to conduct ten additional sorties in 1979; these took place on 22 and 31 May, 15 and 28 June, 27 July, 20 and 29 September and 5, 16 and 20 October.

▲ Line-of-sight distance is about 320nm from 80,000ft, depending upon prevailing weather conditions. The features distinguishable at such range would be a coastline, while a mountain range would probably be indicated by cumulous clouds built up over it. The earth's curvature isn't too well defined because water molecules in the troposphere often create a layer of haze. However, as the sun goes up or down through the terminator (the line dividing the illuminated and dark part of the planet), it is possible to see the curvature of the earth. (BC Thomas)

The need to build up a RADINT database of the island dictated that the first four sorties flown in 1979 would use the SR-71's HRR capability. The DIA requested that the aircraft's ELINT systems should also be used, to collect signals data. The 27 July mission, however, was a photo overflight and this was used to help evaluate and validate HRR imagery collected during the four earlier RADINT missions.

During 1980, just five Giant Clipper sorties were flown, these taking place on 15 January, 2 February, 17 March, and 3 and 22 July. The dates on which the SR-71 executed the majority of its Giant Plate/Giant Clipper sorties can be attributed directly to two periods of increased tension between the United States and Cuba. The first was the MiG issue, the second the build up of Soviet troops on the island.

The latter led to frenetic behind-the-scenes negotiations with the Soviet Union, which continued to insist that the role of its people on the island was no different to what it had been prior to 1979. But such statements failed to pacify the Carter administration and it announced the implementation of five policies in response to the brigade's presence. The first of these was to increase the level of US surveillance of Cuba and the eight Giant Clipper sorties flown between 5 October 1979 and 22 July 1980 were a central plank of this policy. Other measures included reassuring Latin American nations that the US would protect them against any Communist incursions; it also promised an increase in the number of US military exercises in the Caribbean and provided greater levels of economic assistance to the region, as well as establishing a US Caribbean Joint Task Force with its headquarters at Key West, Florida.

From early April 1980, thousands of Cubans unhappy with the nation's communist regime sought political asylum in the Peruvian embassy in Havana. Later that month, after much wrangling, Castro allowed any disgruntled Cuban national to seek asylum in the United States. This resulted in a deluge of people leaving the island on more than 600 small boats owned by Cuban-Americans living in Florida and intent upon transporting their friends and relations off the Caribbean island to 'The Land of Plenty'. By mid-summer 1980, it was estimated that 125,000 refugees had arrived in Key West.

The Giant Clipper sortie flown on 3 July 1980 provided the photo interpreters with outstanding imagery in which it was possible to establish that the mass exodus off the island had ended. They counted two large merchant vessels, one small merchant ship, 28 fishing

▲ With SR-71 flight time at a premium (a pilot would only fly three or four times a month), Beale's Northrop T-38 Talons provided a cost-effective way for Habu pilots to keep their skill-set sharp; they'd fly the type eight or more times a month. (Paul F. Crickmore)

boats, and one probable factory ship in the harbour, but no people. A merchant ship approximately 185ft long and of the type that had been used to transport refugees was tied up at Mariel, its desks clear of people and cargo. The SR-71's imagery also showed two unoccupied tents erected on the pier near the merchant ship; they had been cordoned off with ropes. The photo interpreters found no groups of probable refugees in the quay area, the Rio Mosquitos refugee processing site was being dismantled and 31 of the known 45 tents used as temporary accommodation were also gone. To ensure that both SAC HQ and the DIA had the most timely information available, imagery interpreters at the 9th RTS provided them with telephonic and teletype reports, so that these could be immediately relayed to the White House Situation Room.

Five years later, Cuba was still being watched. Maj Lionel 'Stormy' Boudreaux and Maj Ted Ross departed Beale at 0400 hours on 19 June 1985 in '980 on a Giant Clipper sortie. After their first air refuelling north of Salt Lake City, they turned southeast toward the target area. Castro had always held a belligerent attitude toward the US and almost inevitably his missile crews frequently spoofed SA-2 firings against the overflyers. Many crews believed it was only a question of time before a SAM was fired their way, so advanced DEF systems were carried to counter such action. Part of the pre-penetration procedure saw the DEFs fully checked out and the aircraft flying up to maximum speed before backing off to cruise speed to ensure that the inlets were performing at their best for SAM dodging.

After '980 reached Mach 3.2 to test full-speed operations, Stormy began backing off to Mach 3.0 cruise while Ted checked out the new DEF system. At that instant, the nose pitched up more than 10° before Stormy could reach the stick to stop the rise. Since he was flying with his right hand on the autopilot pitch wheel (where the right index finger moved a very small control wheel to adjust fine increments of nose-up or nose-down deflection), his hand was out of position for immediate reaction. He quickly moved his hand to the stick and exerted enough force to stop the dangerous pitching action.

Since Stormy was beginning to slow down, the aircraft was in a nose-up trim condition when all three DAFICS computers decided to shut down. The SR-71 was well out of trim and the SAS was not there to help when it was most needed. Without the SAS to dampen Stormy's sharp nose-down input, '980 responded with an equally sharp nose-down sweep of more than 15°. Stormy jerked the stick back, which caused a sudden up-sweep, as he recalled:

I had little time to analyse what was going on because things were happening so rapidly. Unfortunately, each oscillation was getting larger. It seemed that I was trying to learn the flight characteristics of a completely new airplane in a few seconds. Certainly, I'd never experienced anything like this before. In training we were only allowed to fly the aircraft with either pitch or roll or yaw SAS off, and that was at a benign 25,000ft at 0.90 Mach. The loss of one channel of SAS was an abort item.

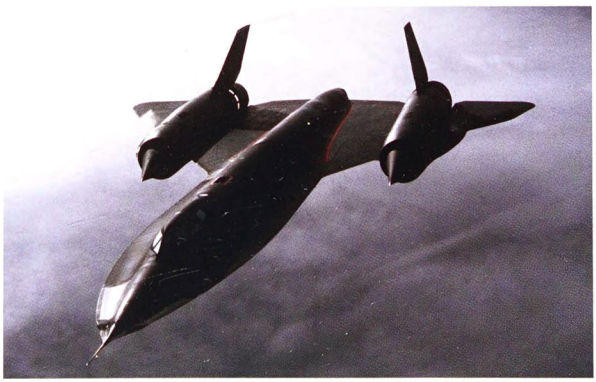
I tried hard not to over-control the aircraft and to get the nose back on the horizon. As the nose reared up again to an ungodly 20°, I knew that this would probably be the last chance I'd get before the aircraft exceeded the restoring capability of the controls. The aircraft would surely depart the flight envelope and disintegrate. Fortunately, I was still flying straight ahead, though we were still well above Mach 3. We hadn't deviated from our flight path and these oscillations were exposing the aircraft's underside forebody to awesome airstream loads. As the nose came up again, I hit the forward stop on the stick and still the nose kept rising. When it stopped I cranked in just a little forward trim and, by the grace of God, the nose started coming back down! I eased off some stick pressure, just enough to stop it deviating by much more than 5°, from which I could progressively make smaller pitch movements.

When I got that bucking bronco back to some proximity of level flight with the pitot tube near the horizon, I tried to maintain that position while I groped around the base of the stick for three red-cover 'guarded' re-set switches for the DAFICS computers. They were low and to the right and I was holding the stick with my right hand and trying with my left to reach around behind the back of the stick to reach these switches. Unfortunately, the metal cuff ring that secured my gloves to the rest of my pressure suit kept hitting the stick, causing the aircraft to pitch and roll. I soon realised that I'd have to change hands. I managed to do that without over-controlling and was finally able to engage the SAS channel. After that success, the rest was easy.

When we analysed the MRS printout back at Beale, I learned that the inlet restart switch had activated automatically following the DAFICS shutdown. This action caused the spikes to travel forward and had opened the forward bypass doors that prevented unstarts, which would have added to our woes.

Through all of this excitement, Ted remained remarkably calm despite the 6lb checklist ripping free from the two 6×6in. Velcro pads that had held it on his lap. It's during such frightening emergencies that I'm in awe of RSOs, who have to read checklists and sit it out. At least the pilots have plenty to keep themselves busy with, and less time to consider their fate.

Stormy aborted the mission and recovered to Beale, where it was discovered that the triple DAFICS computer shutdown was caused by a voltage drop triggered when Ted activated the new DEF system (something the engineers had said could never happen). The fault circuitry in the computer had detected this power loss and it shut down.



▼ Aspin 31 sideslips to the right, having topped up its tanks during a training sortie from Beale on 3 December 1986. (Paul F. Crickmore)

Flying a visual training circuit at Beale, '968 lowers its gear on the down-wind leg. Note the 12 SR-71 'barns', two of which are open, and the four U-2s parked opposite. There are 11 KC-135Qs on the tanker ramp, five in grey and six camouflaged. (Lockheed Martin)

NICARAGUA

Some months earlier, SR-71s had overflown Nicaragua for the first time. After the downfall of the dictator Samosa, a Marxist government was established, which immediately requested Soviet military aid. In the autumn of 1984, a team of US 'crateologists' became interested in a cargo on board a Soviet freighter that had docked in Nicaragua. Photographs taken by a US reconnaissance satellite showed what was believed to be MiG-21 interceptors. Nicaragua denied that the crates contained MiGs and maintained that the cargo consisted of Mi-8 "Hip" helicopters.

After presidential clearance, six reconnaissance sorties were flown over Nicaragua from Beale. The first was flown on 7 November 1984, by Maj Bob Behler and Capt Ron Tabor (this crew flew three of the six sorties over Central America). As a result of their work and correlative intelligence, the MiG-21/Mi-8 wrangle slowly faded from the headlines, along with rumours of a possible US invasion of Nicaragua. Some months later, the world's press confirmed that no MiG-21s had been shipped to Nicaragua: – on this occasion the photo interpreters were off the mark.

AIR FORCE LOGISTICS COMMAND

The Palmdale facility was used as an acceptance test centre. An Advanced Systems Project Office (ASPO) was established and each new aircraft was subjected to extensive functional check flights before delivery to the Air Force. Every new SR-71 would then be picked up by a Beale crew and delivered to the 9th SRW. On 31 December 1970 the functions of this unit were transferred from Air Force Systems Command (AFSC) to Air Force Logistics Command (AFLC), and Det 51 of AFLC was created. The unit reported to the Sacramento Air Logistics Center and had subdivision offices at Norton AFB at San Bernardino, California, near to the contractors and subcontractors.

The function of the ASPO was to provide total logistics support to the SR-71 programme, including maintenance support (spares, major overhauls, and testing and evaluation of new or upgraded systems). A September 1977 reorganization placed the duties of Det 51 at Plant 42 in the hands of Det 6. Command of this new detachment was at Norton, with further lines of command to Wright-Patterson AFB in Ohio.

The two flight test crews of the Det 51/6 Flight Test Division flew missions on dedicated flight-test aircraft, and in addition conducted FCFs on recently overhauled fleet aircraft. All fleet modifications were first extensively flight tested at Palmdale. Such comprehensive testing encompassed all airframe, engine, subsystems and sensor/defensive systems that would ultimately be incorporated in improved fleet aircraft. Virtually all aspects of the SR-71's mechanical and sensor systems were modified and updated during the course of the programme. At any one time, contemporary and advanced technology systems and capabilities were fielded.

▼ To prevent the extended tail from ground contact during rotation, or the brake 'chute from fouling during landing, the tail was hydraulically repositioned 8° 30 in. up or down. (USAF)

Significant programmes tested at Palmdale included high-Mach/high-bank angle envelope clearance, a high-Alpha (angle of attack) warning and protection system, DAFICS, electrical system replacement, stability system improvements and advanced sensor and defensive system qualification. Literally everything from nuts and bolts to newly manufactured and uprated engines were all extensively tested. The dedicated flight test crews (one crew selected from the USAF Test Pilot School, the other coming

from the operational fleet) flew between 150 to 200 hours a year, and were supported by Lockheed ADP maintenance and engineering personnel from 1970 to 1990.

To remain ahead of Soviet missile development, the Air Force asked Lockheed engineers to develop an aft-directed ECM system to be used against advanced missiles. Additional fuselage space was necessary to accommodate the real-time data transmitters. Design consideration was given to equipment pods and conformal packages, but an extended tail became the favoured option. Such a modification added considerably more volume, involved minimum airframe and systems modifications, produced low aerodynamic drag and was relatively cheap. After the Air Force accepted the new design, '959 was transformed into the 'Big Tail' SR-71.

▲ The most striking modification made to an SR-71 from the operational fleet was that applied to 61-7959. Known as 'Big Tail', the 8ft 10 in. extension was added to house additional sensors and ECM equipment. (Lockheed Martin)

Proof of the concept began on 20 November 1975, when Lockheed test crew Darrell Greenamyer and Steve Belgeau conducted high-speed taxi tests. The new tail unit was almost 9ft long, weighed 1,273lb, added a volume of 49cuft and could carry a maximum payload of 864lb. To prevent it from contacting the ground during the take-off rotation and to keep the drag 'chute from fouling it on landing, the tail was hydraulically repositioned 8½° up or down.

A second test was conducted by the same crew on 11 December. During this first airborne test, Greenamyer accelerated to Mach 1.27 so engineers could evaluate the stresses on the added fuselage section. Eleven flights later, Lockheed handed Big Tail over to Det 51 at Palmdale. On 5 May 1976, Lt Col Tom Pugh and Maj John Carnochan chalked up the first Air Force test flight in the aircraft. On that sortie '959 was equipped with DEF J and an optical bar camera nose.

The test series included a Mach 3.0 flight on 4 August, after which the Air Force test crew certified the modification as 'having no detrimental effects on the aeroplane's handling characteristics, or its maximum Mach, while considerably enhancing the SR-71's overall mission capabilities.' To further demonstrate its enhanced mission capabilities, Big Tail was flown with two OBCs, one in the nose and one in the tail. Later the chine bays were deepened to accommodate two further OBCs in each. It was later found that the intercept capabilities of the SA-5 were less of a threat to the SR-71 than had been anticipated, and it was determined that the fleet would not require the Big Tail mod for an aft-facing ECM suite. With the test series complete, Lt Col Pugh and Maj Bill Frazier crewed the unique aircraft on its final Det 51 flight on 24 October 1976.

The prime test airframe for many years had been '955, but by 1985 it had become so highly modified that it was no longer representative of the fleet configuration. Lt Col Tom Tilden and Lt Col Bill Flanagan flew 'ever-reliable' '955 on its 722nd and last sortie on 24 January 1985. Four days later, the same two crewmembers conducted a runway roughness evaluation in the jet and then returned it to the Palmdale storage barn, where it remained for six years. In 1991, '955 re-emerged for permanent display at the Air Force Flight Test Center Museum at Edwards AFB.

The test role passed to '972, which was fresh out of programmed depot maintenance and an FCF by BC Thomas and J. T. Vida on 22 January 1985. Its final flight was on 6 March 1990 when Ed Yeilding and J. T. Vida delivered the jet to the Smithsonian National Air and Space Museum following a record-breaking flight across the US. During its time with the division, '972 flew 417.9 hours in 163 test sorties.

CHAPTER 11

OL-8 TO DET 1

Strategic Air Command was both a major command of the US Air Force and a Joint Chiefs of Staff specified command. Headquarters USAF assigned SAC the responsibility for all strategic reconnaissance and the command executed its mission under the supervision and guidance of the Chief of Staff, US Air Force.

In part, the Commander-in-Chief SAC (CINCSAC – pronounced 'sink sack') was directed 'to prepare plans for strategic aerospace reconnaissance for which the Air Force [is] responsible (electronic, weather, visual, aerial, photographic, cartographic, reproduction, and related activities) to meet the global requirements of the Department of Defense.'

As a specified command, SAC received assignments directly from the JCS, which included photographic and signal coverage of selected areas together with global upper atmospheric sampling. Requirements for individual reconnaissance programmes were specified and outlined

◀ The 9th SRW's detachment at Kadena inherited first-rate facilities from the CIA's project Black Shield. The four hangars had the maintenance complex located in the middle. In the early 1970s, at the height of the Vietnam War, SR-71s occupied all four hangars. Also easily visible are the two JP-7 fuel storage tanks. (Lockheed Martin via Tony Landis)

in operations and fragmentary orders. Through its Strategic Reconnaissance Center at Offutt AFB, Nebraska, Headquarters SAC exercised operational control over all such missions, supervising their planning, scheduling and execution, unless such functions had been specially delegated in a SAC operational order.

In the specific case of SR-71 operations, code named Giant Elk by SAC, these were planned by specialists in the SR-71 branch at the SRC in response to tasking by the JCS, initially in support of the SAC Single Integrated Operational Plan, the Defence Intelligence Agency the Commander-in-Chief Pacific (CINCPAC), Seventh Air Force, Military Assistance Command Vietnam and Commander United States Air Forces in Korea (COMUSKOREA). Senior officers at the SRC participated in twice-daily meetings, one held at 7:30am, the other at 3:30pm, to review current mission tasking, planning and the weather. Once the SRC had completed the mission planning process, details were forwarded to the JCS for final approval.

BUILDING 500

Frank Stampf, a former F-4 weapon system officer and Habu RSO, provides first-hand insight into the workings of the SRC:

> Headquarters SAC, Building 500, Offutt AFB, Nebraska, was the place where the means to carry out America's Cold War doctrines of 'strategic deterrence' were planned and directed under considerable secrecy, and even more considerable security. SAC was the keeper of two legs of the nation's nuclear 'triad' – the strategic bomber fleet and the intercontinental ballistic missile force. (The third leg was the US Navy's nuclear ballistic missile submarine fleet.) As such, SAC had responsibility for developing and maintaining the plans – and capability – to conduct nuclear strikes on thousands of Soviet and Warsaw Pact military and industrial targets, should the president ever determine it was time to give the order. Consequently, the SAC Headquarters building had more than its share of high-level security measures to protect that capability. Building 500 itself was a cross between rather nondescript boxy brick and glass architecture and an imposing presence, depending upon how much one knew (or cared) about what went on inside the structure.
>
> To provide a bit of context, it must be understood that any description I give of that building is from the perspective of a crewmember who did not grow up in the SAC environment. At the risk of stereotyping, I don't think aircrews of that generation would argue with the notion that Tactical Air Command fighter crews enjoyed having themselves characterized as the 'devil-may-care-scarf-flying-in-the-slipstream' type of aviators who rarely broke the rules, but generally did everything possible to bend, circumvent, or otherwise 'beg forgiveness rather than ask permission'. On the other hand, at least in the eyes of the fighter crews, SAC was the realm of the 'hard core-do-it-by-the-book, by God' aircrews who never, ever would even *dream* of operating outside the tightly defined constraints of SAC's nuclear strike mission guidelines.
>
> In retrospect, this was certainly not a *bad* thing – remember Slim Pickens as the hat-waving cowboy B-52 pilot who rode his atomic bomb like a rodeo bull right down to his assigned 'commie ground zero' target in the movie *Dr Strangelove*? That was definitely a product of Hollywood. The point is that once one was inside the Headquarters SAC building, the atmosphere was pure business, and it was apparent that the business being conducted within those walls was deadly serious.

Having said all that, SAC Headquarters, even viewed from the eyes of a TAC-bred aviator, was a pretty amazing place. By the early 1980s, Building 500 was one of the first military facilities, at least that I saw, that had concrete barriers placed strategically around the building so that a would-be attacker could not (at least not easily) drive a car laden with high explosives into the front lobby or other entrances. Even those personnel assigned to the headquarters had to park quite a distance from the building and walk, winding their way through the maze of barriers (usually, it seemed, in a snowstorm) before reaching the front entrance. Once inside the lobby, you could go no further than the security desk, where you had to show the young airman of the SAC Elite Guard your SAC ID badge. The badge, if properly annotated, authorized the bearer into the building, but did not necessarily give access to *all* of the building once inside. Each individual's badge was designed to allow access only into those specific areas for which the individual was cleared and had a 'need-to-know' regarding the work being carried out behind the doors.

After being properly identified by the guard and allowed to pass the main desk, you would then slide your badge into the slot of a turnstile barrier, similar to those used in the subway systems of large cities. Once again, your badge would be automatically 'read' by the security system to ensure that you indeed were authorized access into the building, and the turnstile would unlock, letting you past the front lobby.

For us 'recce' types who worked in the Strategic Reconnaissance Center that was the last light of day we would see for a while, since the SRC was located in the lower depths of Building 500. A few feet after passing through the turnstile we would begin the descent down the several flights of stairs taking us to the basement 'vaults'. Once downstairs, a short walk would put us in front of the secure entry door to the SRC. Again, the ID badge was run through a slot and if all was correct, the door would open to let you into the world of strategic reconnaissance.

As you entered the SRC your first sight was the operations desk, which was manned 24 hours a day, 365 days a year. Behind the desk were two duty officers, both former strategic reconnaissance crewmembers, and an enlisted operations specialist, who assisted the duty officers in keeping track of all the recent, ongoing, and upcoming reconnaissance missions flown by RC-135, U-2/TR-1 and SR-71 aircraft all over the globe. Needless to say, the level of activity behind the desk was pretty constant, with secure phones and other communications media in a regular state of cacophony, reporting the status of real world reconnaissance sorties flying from operational detachments around the world and around the clock. Well before the days of high-tech computer capabilities, all those sorties were tracked and displayed on nothing more than a large black, back-lit grease board using varying colours of grease pencil to annotate sorties scheduled, airborne, complete, delayed, or cancelled; and guess what – even without the technology it worked just fine …

Turning left from the ops desk took you into the offices and planning areas for the RC-135 fleet. Turning right would take you through the SRC briefing room, decorated with photos of strategic recon aircraft dating back to the early days of the Cold War. Passing through the briefing room led to 'high-flyers' country. This was the area occupied by the U-2/TR-1 and SR-71 folks. After passing the office of the colonel in charge, the short hallway opened up to the large mission planning area shared by the U-2/TR-1 and SR-71 planning and operations staffs.

The space was divided longitudinally by an oversized planning table, peaked along the top with sides sloping to either side, one facing the U-2/TR-1 troops and the other the SR guys. The large slanted surfaces, very much like drafting tables, gave us a place

to lay out the navigation charts we used to review and/or plan the sorties being flown at our operational locations worldwide. Although the majority of the more 'routine' missions were planned at the operational detachments, SRC staff still assisted the detachment planners in preparing for high-priority sorties that were out of the ordinary. Each of the SRC staff members also had a desk in the room, which allowed us to pass information easily among ourselves (or just shoot the breeze in the rare 'slow' moments).

The entire area, from the point you opened the door to enter the SRC near the ops desk, was specially designed and built as a Special Compartmented Intelligence Facility, or SCIF. Therefore, it was permissible to have highly classified information and materials out in the open, and to discuss classified mission details with other staff members. This greatly simplified the planning and coordination process. Underneath the planning table were rows upon rows of sectional navigation charts covering every area of the world. These were the days before sophisticated flight planning computers and Global Positioning System technology were in use. Consequently, the slim tolerances for navigational error when planning an SR-71 mission to be flown at 2,000mph within tenths of a mile of politically sensitive borders required extremely accurate planning and execution. Every detail of mission plans, especially for the more demanding and high-visibility sorties, was checked and re-checked by the planners, both at the operational detachments and at SRC.

No description of the SRC could be complete without mention of 'The Phone'. In a small booth at the far end of the large planning room was a black telephone with a very distinctive (and particularly annoying) ring. It was the 'secure' line with which we communicated secret stuff with anyone we needed to outside of the SRC SCIF. This included our counterparts at the Joint Recon Center in the Pentagon, the SR-71 wing in California, and the operational detachments in Okinawa and England. It also included the folks at the National Security Agency, the Defense Intelligence agency, and, once in a while, the Central Intelligence Agency.

All of us at the SRC worked lots of long hours, many nights and regular weekends. As a result, we all enjoyed those rare moments when everything appeared to be under control, we were ahead of the power curve for any known tasking coming down the pipe, and the generals in the building were (for once) preoccupied with something, or someone, other than us. Every so often, that unique confluence of conditions would occur on a Friday afternoon. As the hours of the day slipped by, we all began to hope against hope that the clock would finally read 1730, we would be able to close up the shop, and at least temporarily leave the reconnaissance world in the hands of the guys at the ops desk. We would plan to slip off to the Officers Club for a well-deserved beer and the opportunity to swap war stories of our longed-for flying days.

Almost inevitably, just as we were almost tip-toeing toward the door and about to turn off the lights, 'The Phone' would blast its annoying clanging ring as if to say 'not so fast, you recce pukes …' And another long night would just be beginning.

THE STAGE IS SET

When President Johnson endorsed the CIA Director's 31 December 1966 decision to terminate the Oxcart programme, a schedule for the phase-out of the A-12 fleet was formulated to meet a 1 January 1968 deadline. On 10 January 1967, the head of the project advised Deputy Secretary of Defense Cyrus Vance that four A-12s would be placed in storage in July, two more in December, and the last four in January 1968.

In May 1967, Vance directed that the SR-71 assume contingency responsibility to conduct Cuban overflights in July, and that the Senior Crown programme was also to be ready to cover Vietnam by 1 December 1967. His directive provided for a short overlap between the outgoing 'covert' A-12 programme and the incoming 'overt' SR-71. In the event, the date of the changeover slipped five months, giving Oxcart a brief stay of execution.

As the 1st SRS neared operational readiness, decisions were made by Colonel Bill Hayes (the 9th SRW commander) and Colonel Hal Confer (the Director of Operations) as to which crews would be first to be deployed to Kadena Air Base on the island of Okinawa. The eight crewmembers they selected began training for the deployment, flying simulator sorties depicting the oceanic route they would fly.

It was also decided that the crew who ferried the first aircraft to Kadena would fly the first operational sortie over Vietnam. The predetermined sequence would also include a fourth crew in the operational line-up, who rode a tanker to Kadena. Each SR-71 departure would be backed up by a spare (with the fourth crew), in the event of the primary aircraft having to abort due to No-Go discrepancies.

Two days before the Glowing Heat event – a code name reserved for SR-71 positioning flights – six tankers were flown to Hickam AFB, Hawaii. SAC code named the SR-71's KC-135Q tanker support Giant Bear. Initially three units were designated to perform this vital task: the 903rd ARS based at Beale, the 306th ARS at McCoy and the 909th ARS at Kadena. On 1 July 1971, support was increased to four squadrons, the 9th and 903rd ARS at Beale, the 306th ARS at McCoy and the 70th ARS at Little Rock.

The SR-71 crews agreed to draw straws, leaving the choice of who would go first in the hands of fate. Dave Dempster held the four straws of varying lengths and the RSOs from each of the other three crews drew one. With the luck of the draw, Dave Jensen's straw decided that he and Buddy Brown would fly the first aircraft across the Pacific and hopefully the first 9th SRW ops sortie from Kadena. Jerry O'Malley and Ed Payne would fly the second deployment and Bob Spencer and Ruel Branham the third. Dempster was left holding the short straw, so he and Jim Watkins would ride the tanker unless one of the other crews came up with a 'sick jet'.

Command of the Operating Location would be alternated between the 9th SRW's wing commander and vice commander (and later the deputy chief of operations). The first detachment commander would be the vice commander, Col Charles Minter, and Col Carl Estes would be the director of maintenance. With the tankers safely at Hickam AFB, Maj Harlon Hain (the 1st SRS operations officer) set up a down-range radio station on Wake Island to provide emergency radio coverage. All was now ready for Brown and Jensen to make a record-breaking 5-hour flight across the Pacific, the sortie being flown at a speed twice as fast as the existing world record.

DEPLOYMENT

At 1000 hours on the morning prior to their departure, Brown and Jensen (along with their back-up crew, Watkins and Dempster) received their pre-mission briefing. Since this was the 9th's initial deployment outside the US, the briefing was attended by the wing commander and many others. Mission planners briefed the entire flight profile for the sortie, which would begin at 1100 hours on 8 March.

After take-off they would head west from Beale to a point 50 miles north of San Francisco, where they would light the burners for a dash to 75,000ft to check that all systems were functioning normally before descending to the first air refuelling. With a clean bill of health

on the Habu and a top-up of fuel from the tankers, Buddy and Dave would race to another refuelling northwest of the Hawaiian islands, where they would 'buddy cruise' with the tankers for half an hour to take them to a point where they would be 'single-engine capable' to the island of Iwo Jima as an emergency landing base.

After the mid-Pacific refuelling, a third Mach 3.0 dash would take them to their third and final top-up west of Wake Island, where a maximum off-load would give them enough fuel to reach Kadena and go to an alternate base on Taiwan should the weather deteriorate over Okinawa. During the briefing they were informed that the weather was expected to be good in the refuelling tracks, at Kadena, and at their emergency landing bases, and that they could expect a comfortable crossing. After a maintenance briefing and some good humour, the two crews began official crew rest.

At 0730 the next morning the four crewmembers reported to the PSD for a final weather briefing and a maintenance report on their aircraft. This was followed by the standard pre-flight physical examination and high protein/low residue breakfast (steak and eggs, and orange juice). After one last trip to the urinal, suit-up began. Two PSD suit technicians aided each crewmember as he donned his full pressure suit. A communications check and pressure suit integrity test confirmed that each garment was functioning properly, and after a 10-minute nap the crews were transported to their respective aircraft – Brown and Jensen to '978 and Watkins and Dempster to '980.

After 'strapping in and connecting up' they began the normal 'challenge and response' cockpit checklists, which took them through engine start, taxi and pre-take off procedures. With engines revved to full military power and all instruments 'in the green', Buddy released '978's brakes and lit both burners, the SR-71 rapidly rolling down the Beale runway and lifting off into the vivid blue morning sky. He recalls:

> After crossing the coast of California, I started our transonic acceleration climb profile to altitude. This portion of the flight was considered mission critical because the spikes, forward and aft inlet doors, inlet guide vanes, and nozzles all had to check out prior to committing the 'bird' to the Pacific high-flight. Everything was 'up tight' so we were on our way. We again accelerated on our next leg to the third and final refuelling. Approximately 20 minutes after level off at 79,000ft, I encountered a problem that could have forced me to land at Johnson Island. My right spike (for no apparent reason) went full forward, which caused a very large yaw moment (lots of drag). I checked my cockpit over and found a popped circuit breaker, which (when reset) brought the spike back to its normal 'bottomed' position for high Mach flight.
>
> The third decel, AR and climb were also normal, but when we were back at altitude I encountered another potentially serious problem. My left generator went offline and I couldn't reset it. This was a No-Go situation, which meant I should land as soon as practical. My decision was to continue on because we were less than 1,000 miles (about 30 minutes) from Kadena. I used my coded call sign and contacted 'Mamma' and informed them that 'I was lost, but making good time'. We landed at Kadena with the failed generator, but the first SR-71 had already arrived and was soon ready to start reconnaissance operations in South-East Asia and wherever else the national authorities might require.
>
> We had taken off from Beale at 1100 and arrived at Kadena at 0905, nearly two hours earlier than take-off time (but in the next day because we had crossed the international date line). We beat the sun by a good margin.

Two days later O'Malley and Payne delivered '976 to OL-8. They had departed Beale much earlier in the morning and landed at Kadena at 0330 hours Japan time. Spencer and Branham delivered '974 on 13 March. Three days later the KC-135 carrying Watkins and Dempster arrived at Kadena. It was late in the evening and raining hard when the tanker unloaded its weary passengers. As the last two SR-71 crewmembers stepped from the tanker to what should have been a rapturous welcome from the others, they were met by a junior NCO who was there to drive them to their visiting officers quarters in a blue Air Force maintenance van. The newcomers felt deflated as the NCO murmured a weak apology for the sparse turnout, dismissing it as 'high work load due to operational requirements'. As they opened the door to their visiting officers' quarters (VOQ) room, they were greeted by the entire gang of crewmembers and senior staff, who cried out the raucous wartime welcome, 'Hello assholes. What took you so long getting here?' OL-8 was now fully manned and it was time for a 'little celebration'.

The Kadena detachment was known as Operating Location 8 (OL-8), which followed the numerical designation pattern of SAC's overseas reconnaissance locations. It was redesignated OLRK (Ryukyu, the name of the island chain that includes Okinawa) on 30 October 1970, then changed to OLKA on 26 October 1971, changing yet again, to Detachment 1 of the 9th SRW, in August 1974, a title which it retained until 1990 when the SR-71 fleet was retired.

The operational deployment of the SR-71 to Okinawa also led to the aeroplane's Habu nickname, after a dark, poisonous pit viper indigenous to the Ryukyu chain. Although the nickname Blackbird has long been publicly associated with the SR-71, it has been shunned by crewmembers and others closely connected with the Senior Crown programme, who favour Habu. The name stuck, and Dave Jensen designed a colourful detachment flight jacket patch with the snake interlaced around the figure eight.

Colonel Charlie Minter was the chief architect of most of the operating procedures for OL-8's crews. Those rules proved so sound and well structured that the majority of them remained unchanged throughout the entire 22-year life of the Kadena operation. Maintenance teams from the 9th SRW that manned OL-8 were the best at their jobs and considered the cream of Air Force maintainers. Col Carl Estes' hand-picked Habu technicians had done high-priority work on the three jets as they arrived and had all of them ready for operations by 0900 hours on 15 March 1968, when the unit was declared 'fully OR' (operationally ready).

On Monday 18 March, OL-8 was ordered to fly its first operational sortie. As previously agreed, Buddy Brown and Dave Jensen began preparing themselves for the mission. As a hedge against crew illness or aircraft system failures every operational sortie was backed up by a spare aircraft and a suited-up aircrew who were equally prepared for take-off orders. The standby crew on this occasion was Jerry O'Malley and Ed Payne. Although everyone was 'all set' for the mission, it was cancelled by higher authorities and Buddy and Dave flew a 'Cathy' training sortie instead. As previously agreed back at Beale, the next crew to fly was Jerry and Ed.

▼ The Habu, a poisonous viper indigenous to Okinawa and from which the SR-71's nickname was derived. (Paul F. Crickmore)

TO WAR

On the morning of Thursday, 21 March 1968, Maj Jerry O'Malley and Capt Ed Payne completed the first operational mission of the Senior Crown programme, in '976. The aircraft was equipped with a SLAR in the nose section, a downward-looking, vertically mounted TROC for ground track verification, and an AR-1700 radar recorder in the N-bay, within the right

chine. Behind the cockpits in the P and Q-bays were the left and right long focal length 'close-look' TEOCs. Finally, bays S and T accommodated two OOCs.

Having topped up the fuel jet's tanks shortly after take-off, Jerry accelerated and climbed '976 to speed and altitude before penetrating North Vietnamese airspace in a so-called 'front door' entry over the port of Haiphong. The route was virtually identical to that flown by Mele Vojvodich in his Oxcart ten months earlier. The Air Force crew flew over Hanoi before exiting via Dien Bien Phu, having spent just 12 minutes in hostile airspace. Jerry then decelerated and descended into the designated refuelling track in Thailand.

Craven 'Gibb' Gibbons, flying the lead tanker, timed his turn to perfection just as '976 arrived at 25,000ft, a few miles behind and 1,000ft below the KC-135Qs. A split fuel load from the two primary tankers filled the SR-71's tanks, ensuring that the services of the third, spare tanker wouldn't be required.

O'Malley then repeated the climb and acceleration routine up to their prescribed altitude, on track for the second and final take of the mission. This run was to be flown over the demilitarized zone (DMZ) between North and South Vietnam, the primary objective being to locate the heavy guns and supporting infrastructure that were involved in the North Vietnamese siege of Khe Sanh.

For this run, the primary sensor was the SLAR, which could penetrate the heavy jungle canopy, but when Ed Payne had earlier conducted a BIT test of the system it had failed. He reasoned that no damage could be done to the system if he positioned it manually and took some shots on the off chance that it would find something, however. With the run complete, the jet exited the sensitive area and the crew made their way back to Okinawa.

Inbound to Kadena they were informed by approach control that the base was fogged in. After further discussion it was agreed that an approach could be flown in an attempt to conduct a visual landing. Using ground-controlled approach radar assistance, Jerry descended as low as was prudent into the fog – the crews on the ground reported he was below the tops of the tanker tails, just 30ft above the ramp. Although the approach was good, Jerry was unable to locate the runway and therefore conducted an overshoot.

Low on fuel, he called for the standby tanker that had been launched earlier just in case the weather at Kadena turned nasty. After link-up, he took on 25,000lb of fuel while Ed copied a two-figure encoded number that told them their divert airfield location, Ku Kuan on the island of Taiwan. Two additional KC-135s were launched to accompany '976 to nationalist China, the SR-71 adopting a tanker call sign as the number two aircraft in a three-ship formation. This deception was undertaken to hide the inter-island diversion from SIGINT monitors on the Chinese mainland. As the Habu made its way 'low and slow' with the tankers, the destination airfield's non-directional beacon returned the unexpected Morse code identity signal CCK. The tanker crews soon resolved this problem – it turned out that Ku Kuan had recently been re-named Ching Chuan Kang.

Jerry asked the CCK tower for permission to land and made a straight-in visual approach at 175kt before performing a smooth touchdown. Clearing the runway, Jerry lined up close behind the lead tanker with the second KC-135 tucked up behind as they taxied to the parking area. This unusual sight caused considerable confusion among the tower personnel, particularly when one controller asked for the call sign of 'the little black aircraft between the two tankers that replied with a tanker call sign.' While Ed was talking to the tower people, Jerry dialled up the radio frequency of the SAC command post that had recently opened on CCK and asked for the aircraft to be hangared for security reasons.

Since CCK was a PACAF joint-tenancy base with the Chinese Nationalists, most of its hangars were filled with C-130 Hercules transports. To clear a secure spot for the SR-71, a C-130 up on jacks had to be rapidly lowered back onto its undercarriage and rolled out of a

hangar. The work took 30 minutes, which left the SR-71 standing in full public view close to the base perimeter fence, its engines still running. A crowd of at least 500 Taiwanese gathered 10 to 15 deep along a 300-yard section of the fence, fascinated to see such a futuristic jet standing on their airfield and almost within touching distance.

With the Habu safely hangared and a security cordon thrown up around the area, the take was downloaded and flown to the 67th RTS at Yokota for processing (this 67th continued working with OL-8 until 29 March 1971, after which the 548th RTG, a PACAF unit at Hickham AFB, Hawaii assumed the processing responsibility). The SLAR imagery was sent to Beale, for processing by the 9th RTS, before being sent on to Washington DC for analysis by national-level agencies.

After two nights at CCK, the crew and '976 were ready for a ferry flight back to Kadena. The unrefuelled hop was uneventful, but the reception from their friends and colleagues back at base was memorable. The post-mission intelligence results were also quite stunning.

The SLAR that Ed had manually programmed had indeed worked. Its take revealed the location of the heavy artillery emplacements around Khe Sanh, and a huge truck park that was used in support of the guns; both sites had eluded sensors on other US recce aircraft. Within days of receipt of this intelligence, air strikes were mounted against both targets, reducing their effectiveness dramatically. After a 77-day siege, Khe Sanh was at last relieved on 7 April 1968 (two weeks after '976's 'discovery' sortie). As a result of their significant contribution to this highly successful mission, Maj Jerome F. O'Malley and Capt Edward D. Payne were each awarded the Distinguished Flying Cross. On its very first operational sortie, the aircraft had proven its value, as it would on thousands of other occasions over the coming years.

EYES AND EARS

Shortly after their arrival on Okinawa, the crews were summoned to a briefing in a secure room, where they heard of local efforts to observe their activities. Since the primary building material of Japanese houses was wood, tall watch towers had been built in numerous locations on Okinawa to detect fires in their earliest stages so the local fire departments could quickly contain them. One such tower existed just outside the perimeter fence on the north side of Kadena Air Base, near Kosser Circle. The so-called fire guards had unrivalled views of the entire base from its commanding platform.

During the year of A-12 operations, intelligence officers had correlated positively that whenever an A-12 emerged from its hangar, a red flag was run up the watchtower's flagpole. In addition, it had been ascertained that within five minutes of the flag's lofting, a Soviet 'trawler' (on radar picket duty just beyond the 12-mile limit off the coast of Okinawa) switched on its radar, which remained on as long as the flag remained flying from the tower.

All along the China coast to the Gulf of Tonkin the Soviets had positioned a string of such 'trawlers' to relay tracking information on the Vietnam-bound Habus. An RSO later commented that it was almost like radar coverage back in America, but instead of FAA air traffic centres handing off from one ATC centre to another, the Soviets were monitoring every move. The coordinated tracking was also supported by Chinese "Tall King" surveillance radars along the country's coast and on Hainan Island.

As an A-12 or SR-71 penetrated North Vietnamese airspace, the first SA-2 target acquisition radars would lock on at a slant range of approximately 80 miles. Such monitoring activities caused one crewmember to contemplate a radio transmission on the emergency frequency, saying in Russian 'Good Morning, Comrade'.

What these crews were not told was that US intelligence services had broken the Communists' communications codes. Lacking landlines for point-to-point telephone contact, the Vietnamese had to transmit Habu tracking data to their command centres via broadcasted radio frequencies, which were immediately intercepted by US listeners on Okinawa, Taiwan, South Vietnam and Thailand, as well as by EC-130 airborne listening posts flying over the Gulf of Tonkin. Fluent Russian and Chinese linguists working at these stations would translate the broadcasts into English for secure onward transmission to various allied agencies.

Back at Kadena, a handful of senior officers were privy to that information and could indirectly monitor their aircraft's progress via the enemy's conversations. As an A-12 or SR-71 departed Kadena on an operational sortie, the commander and a few of his key staff members would meet in the Special Activities Office, where a secure teleprinter known as a 'Dingy Whopper' would tell them about the sortie. As one officer described this 'mail reading' exercise, 'We were able to listen to them while they watched us.'

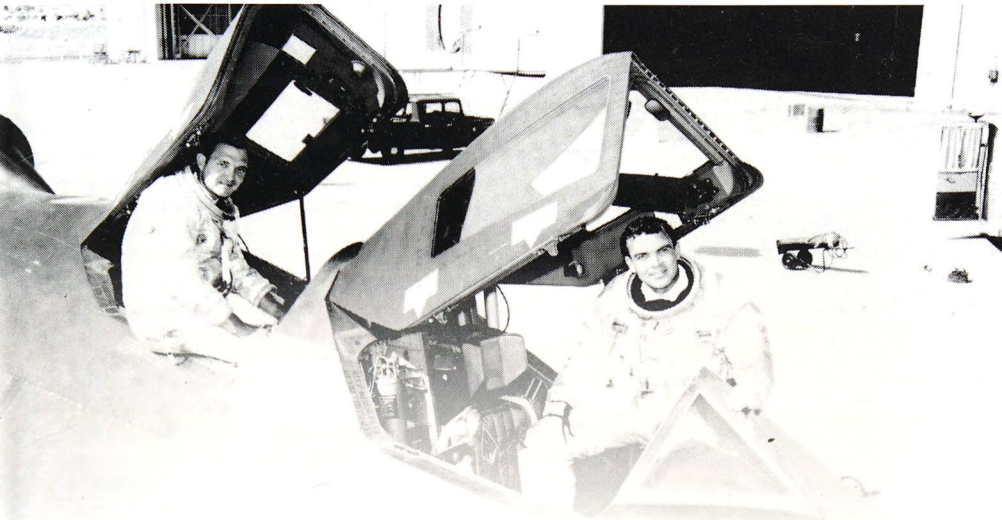
Fate was to intervene and frustrate the other Habu crews who prepared to fly their own first operational sorties, each being cancelled and replaced with a training sortie instead. On 10 April 1968, Brown and Jensen were once again set as primary crew. O'Malley and Payne were suited up as backup. Buddy cranked '974's engines precisely on time and taxied out of the Little Creek area to run up near the end of the runway. Jerry and Ed were sitting in '976 waiting to hear that Buddy and Dave were off and running.

Instead, Crew Chief Tech Sergeant Bill Campbell told them that '974 was taxiing back to the hangar. While Jerry and Ed were getting ready to roll, Buddy and Dave parked '974 nearby, the stricken jet being swarmed over by most of the OL-8 maintenance force. Even Col Estes clambered on top of the jet with his ANS specialists and 'was working like a GI mechanic' to help replace the astro-inertial navigation set. Meanwhile Ed and Jerry were ready, as Ed now recalls:

> We got out there and were running a fast checklist and I happened to look up and here comes Buddy taxiing like a bat out of hell. It must have been a world record ANS change, but I was certain that Dave hadn't had time to get a 'star light' because the system hadn't had time to go through all of its BIT checks yet. Charlie Minter, who was in the mobile control car, obviously was thinking the same thing. Since it was his duty as OL commander to put the best aircraft over the target, he leapt from the car and wrote 'YOU GO' on an 8×10in. pad that he held up to Jerry and I, and 'YOU STAY' on the other side that he showed to Buddy and Dave.

As they climbed away, Jerry and Ed elected to adopt the primary aircraft's call sign since they had made that aircraft's take-off slot. They reasoned that the tankers would be expecting that call sign and that they would minimize confusion by keeping '974's identity. Unfortunately, the call sign change did not help Bill Boltersiders in the CP, who had to dispatch a coded report to HQ SAC immediately after take-off. In his uncertainty as to which aircraft actually departed, he had to wait for Col Minter's return from the flight line before having the necessary details to set HQ SAC straight. The mission got off to a good start and Jerry and Ed were again on their way toward Vietnam, on the 'second' SR-71 combat sortie.

They coasted in near Saigon and made a shallow turn to the right to fly northbound across the DMZ towards Vinh and then on to Hanoi. There was no shortage of high priority targets: Phuken and Ying-By airfields, the steel works, and dozens more. Unknown to the crew, President Johnson had stated that day in a broadcast that no US strike aircraft would fly further north than the 19th parallel. His decision had caused confusion within military circles as to the meaning of 'strike aircraft'.



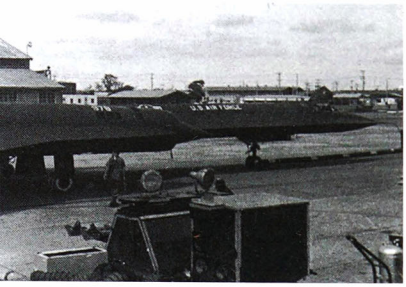
▲ Majors Jerry O'Malley and RSO Ed Payne completed the first operational Habu mission, in '976 on 10 April 1968. (USAF)

The 'ground pounders' at higher headquarters decided to play it safe and sent out an HF radio message intended to withhold the sortie from overflight. Ed received a coded message to that effect from SAC's SkyKing communication's system, over the international Giant Talk HF radio network, but was too busy flying at 33 miles a minute over the prime target area to take time to decode the message, which instructed them to turn left and abort the mission. Some moments later, the autopilot initiated a programmed turn that started them back towards the south. With a few moments between high workload events, Ed told Jerry of the abort order. After completing the turn, they exited North Vietnam near Dien Bien Phu and prepared for descent toward their air refuelling over Thailand.

The two fliers' spirits had been high throughout the sortie, particularly since their good luck had enabled them to fly both operational missions performed so far. The mission had been 'a piece of cake so far', or so they thought, until Jerry eased back the throttles to the pre-assigned descent RPM. At that moment both engines rumbled slightly in a compression stall and immediately flamed out.

An air-start required 450kt KEAS and 7psi on the compressor face to get things 'turning and burning' again. That meant getting down to denser air where those higher values could be achieved. Jerry pushed the nose down hard and Ed recalled seeing the artificial horizon instrument showing all blacks. As they rode the aircraft down to lower altitudes they decided that if Jerry could not get an air-start, Ed would call 'Mayday' at 23,000ft and they would 'punch out' at 14,000. At 40,000ft Jerry gave the throttles a nudge, which gave the engines positive fuel flow and a shot of TEB for ignition. There was no response. He tried again as they were passing through 30,000ft. Still nothing. Ed recalled:

> By now we were both getting a little anxious. I saw the altimeter go through 26,000ft and I was getting set to say 'Mayday! Mayday! Mayday!' I got the word 'May' out when I felt the aircraft shake a little. Realizing that Jerry had finally got something going, I didn't finish the rest of the message. A glance at the altimeter showed us just below 23,000ft and still descending quite rapidly. Just then Jerry said, 'I've got one of them started.' Shortly afterwards he got the second engine fired up and when we hit 20,000ft we had both engines running fine.



▲ The Det's third operational mission, on 18 April 1968, was cut short when Buddy Brown and RSO Dave Jensen were forced to divert '978 into Takhli RTAFB with generator problems. (USAF)

Having received the 'May' of Ed's message, the tanker crews knew that all was not well with the Habu crew. This realization was confirmed as they monitored the air-to-air TACAN's distance measuring equipment (DME) ranging. Ordinarily the SR-71 would make a 'hot' rate of supersonic closure on the tankers, slowing notably only in the final 30 miles. The DME meter would normally be clicking over between 20 to 30 miles per minute during the early part of the deceleration. Instead it quickly slowed to a closure rate of about 8 miles per minute. That speed meant the Habu was low and slow well before intended and way up in 'bad guys' territory. Ed remembered:

> We got our act cleaned up and the first transmission we received from the tankers was, 'Are you guys okay?' I answered, 'No'. They asked, 'What can we do?' I answered, 'Turn north'. The double-engine flameout and rapid descent profile had left '976 down at a 'gas-gobbling' 20,000ft over northern Laos, some 300 miles short of our planned ARCP. We climbed back to 26,000ft and headed south. I recall that the lead tanker navigator was a woman. I'm sure they must have violated operating procedures coming that far north without some form of fighter cover, but we were damn glad to see them.
>
> By the time we reached the tanker, '976 was below 8,000lb of fuel. The tanker turned in front of us and the boomer plugged into our AR receptacle in a heartbeat. We drained 80,000lb of JP-7 out of two tankers and even used a little from the spare – perhaps a record off-load. We used the extra gas because we had to lengthen the air-refuelling track from Laos to mid-Thailand. Had we just filled up and climbed for home we wouldn't have been able to fly the profile properly, so we just stayed behind those beautiful tankers until we reached the originally planned disengagement point.

While Jerry and Ed were refuelling, they discussed what might have caused the double-engine flameout and what would be the preferred action to get home safely. Ed was in favour of staying with the third KC-135 until they met some Kadena-launched spare tankers. Jerry, on the other hand, believed they should fly a normal profile to help determine the cause of the problem. Jerry discussed at length what data he wanted Ed to record, and just prior to the final decel back into Kadena he began reading out RPM, EGT and fuel flow information. He eased back the throttles and the engines spooled down normally. They recovered into Kadena without further incident, thus ending the second operational sortie of the SR-71's reconnaissance career. That double flameout foreshadowed a spate of similar problems that would follow over Laos, earning the Habu the new nick name 'Lead Sled' back at the SAC Reconnaissance Center.

With the first two ops missions under their belts, Jerry and Ed were relegated to flying test hops for the duration of their tour to ensure that the other crews had an opportunity to accumulate combat time. The following week Buddy Brown and Dave Jensen were scheduled to fly a double-looper over North Vietnam. They got airborne in '978 at 11:00am on 18 April and all went well until it was time to decelerate for their first Thailand refuelling. The tanker notified them that the ARCP had been moved due to thunderstorms in the AR area. As they began to decelerate, the left generator went offline and could not be reset. This failure was followed by a double engine flameout. Dave transmitted the necessary codes stating that they were going to make a precautionary landing at Takhli Royal Thai Air Force Base (RTAFB), since generator failure was a 'land as soon as practicable' abort item.

Without power they lost cabin pressurization and their 'moon suits' inflated, which made cockpit movements awkward. As they descended towards an altitude where the engines could be restarted, Buddy requested that the tankers come north to give them additional fuel after the early and rapid descent. At 35,000ft he was able to restart the engines. He then adjusted the aircraft's centre of gravity for subsonic flight and called Takhli approach control, informing them of their impending arrival. The tower controller told them that the tankers had already alerted the CP and they were ready to receive them. On approach, the nose gear's down-lock light failed to illuminate. Buddy made a low pass by the tower to have the gear visually checked 'down' and then circled to an uneventful landing.

The CIA had a secure compound on the airfield from where it conducted U-2 operations and Buddy was able to use one of its hangars. A recovery team arrived from Kadena and readied the SR-71 for its return. As they were preparing to depart, the head of the Agency's detachment told Buddy, 'If you don't tell anyone you were here, I won't either.' Buddy laughed at the 'typical cloak and dagger' remark and thanked him for the first-rate support on their interrupted Habu mission.

On 27 April, Buddy and Dave flew their second ops sortie, this time in aircraft '976. As they started their descent into Thailand, they experienced another double-engine flameout and another failed generator. As they taxied back into the Agency's hangar at Takhli again, Buddy insisted he had not come to join the CIA, but to enjoy their hospitality. On leaving the Thai base two days later, Buddy saluted them with a 'max burner' climb out that 'left them all smiling', the lightly-fuelled Habu climbing steeply away from its newfound second home in South-East Asia.

Tracking down the generator issue required diligent detective work by Col Carl Estes and his maintenance team, because on the ground the generators worked perfectly. It was eventually discovered that prolonged heat soaking at cruise speed was melting the solder that secured wires running from the generators. Back on the ground the aircraft cooled, the solder solidified and the generators came back online. Having identified the problem, the fix was simple; the wires were connected using solder with a much higher melting point.

Following cancellations and disappointments, Jim Watkins and Dave Dempster finally got airborne on 19 April in '974. They topped off their fuel tanks near Kadena and headed out for North Vietnam. Arcing around Hainan Island on their right, they entered the Gulf of Tonkin and reversed left onto their penetration track. This front door entry took them over Haiphong and Hanoi, exiting via Dien Bien Phu.

As on the earlier flights, everything went well until it was time to come down for aerial refuelling. As soon as Jim slid the throttles out of burner, there was an enormous bang, followed by another double flameout. He got both engines started up again after wiping 50,000ft of altitude off the altimeter's reading. The tanker crews responded immediately to the emergency call, heading north without fighter escort into the 'bad lands' of Northern Laos.

While the Habu was on the boom taking on three tons of fuel a minute, Jim had time to reflect on the incident that could have ended in disaster. At that point he said to his RSO, 'Davey, I think I might know what happened and if I hold a couple hundred more RPMs above what it says in the checklist the next time I come out of burner, I might be able to keep the engines alive and we can complete the mission. What to you think?' Dave replied, 'Let's give it a try and do the next run.'

It seems that 'cowboy' Jim Watkins had the first glimmer of an idea that would later be proven when Don Walbrecht and Phil Loignon flew Vietnam to Thailand descents without a problem.

In 1968, OL-8's operational rate was approximately a mission a week. Jerry O'Malley and Ed Payne rotated home earlier than originally planned and were replaced by Maj Larry Devall

and Captain Clyde Shoemaker. Maj Bob Spencer and Maj Keith Branham flew their first operational sortie in aircraft '974 on 22 April: it was a double-looper over North Vietnam lasting 5.5 hours. They were airborne again on 5 May, flying another double-looper, this time in '978, and again the duration was 5.5 hours. The third and final operational flight of their first tour took place six days later.

On 13 May 1968 Jim Watkins and Dave Dempster flew '974 on a two-loop route over North Vietnam using side-looking radar. While on the KC-135's boom during the final air refuelling before the flight back to Kadena, Jim set the cabin pressure altitude switch to 10,000ft. He told Dave he was raising his faceplate for a drink of water. This was an unusual procedure, momentarily breaking the old flying rule 'oxygen over 10,000ft'. After a refreshing libation, Jim closed his visor and informed Dempster that he was ready for the flight back home.

Dropping off the boom, he lit the burners and headed up into the darkening tropical night sky. When he was established in an accelerating supersonic climb, Jim engaged the autopilot's auto nav function as the Habu headed northeast over the South China Sea. It was during this stage of the climb that Dave first perceived that all was not well with his pilot. Jim's words were beginning to become slurred, but as far as Dave could tell, his actions were still okay. However, they had trained together as a crew for well over 100 hours and the RSO was becoming increasingly concerned.

As the climb continued, Jim's speech deteriorated further. Then the gut-twisting reality of the situation hit Dave with full force: his pilot was hypoxic and the RSO had no flight controls to overcome impending disaster. In a matter of minutes Jim would lose consciousness and shortly thereafter (unless Dave could get oxygen into his pilot's lungs), Jim would die and Dave would have to bail out in the vast South China Sea. The latter was not a realistic option for the RSO, and he wondered how he could get Jim's attention.

Luckily the autopilot and auto-nav functions were engaged, which allowed Dempster to exercise the only control inputs that an RSO had from the back seat of an SR-71: lateral steering using nav steering commands, but with absolutely no pitch controls. Dave dialled up 7700 on his IFF panel and squawked 'emergency' to alert the radar watchers in South Vietnam who were monitoring the flight that there was a problem.

One option Dave considered was to turn the aircraft towards Cam Ranh Bay (the large PACAF base on the coast of South Vietnam). He dismissed this idea almost immediately, for in a turn there was a greater chance of an inlet unstart and it was very doubtful if Jim could control the aeroplane in his current state of consciousness, which had become further degraded during the last minute of flight.

Turning towards Vietnam would also have taken the aircraft closer to the 'bad guys' and Dave was determined that he would not leave his pilot or allow any part of 'his' SR-71 to fall into enemy hands. By now Jim was on the edge of unconsciousness. There was perhaps one possible remedy to the situation. Dave summoned up every ounce of command authority in his voice and yelled over the intercom in a clear deliberate manner that 'We are now at the Start Descent checklist'. Inlet guide vane switches to lockout.' Surprisingly, Jim flicked the switches. 'Inlet Controls – Auto and Close.' Jim complied. 'Throttles, 720°.' Again, Jim carried out the RSO's instructions. Slowly '974's altimeter began to unwind. Dave recalled:

> Jim was one hell of a pilot. All of those thousands of hours of flying and training (and here he was about to pass out) and yet he was doing exactly what he was instructed to do. He came out of afterburner; he set the correct RPM and then threw the right switches for the bypass doors. Luckily, we didn't flame out or unstart, and thank God, he didn't disconnect the auto-nav system, so it was still steering us very accurately.

On the way down I monitored my triple display indicator (Mach, KEAS and altitude) readings and by using the profile card that we used to rendezvous with the tanker, I was able to give Jim additional commands like, 'Okay, Jim, you're doing great, just ease it down a little bit, ease it down. Adjust your RPM slightly. Okay, you're right on profile.' He was a disciplined flier and seemed to respond to those commands, and by the help of God, we raggedly descended and decelerated all the way down to subsonic speed and he didn't pass out.

We levelled off at about 25,000ft and cruised at that altitude for a while, where Jim regained a bit of his normal consciousness. Slowly, Jim's voice began to return to normal and he suddenly said, 'What the hell are we doing at this altitude!' I said, 'Okay, Jim, the first thing I want you to do is to open your faceplate and close it again, and check that your bailer arm is down and firmly locked.' He did exactly what I instructed and then started swearing at himself because the picture was beginning to return to him what had happened in the last ten minutes. We stayed 'low and slow' until he appeared clear and sharp again.

I calculated that we had enough fuel to fly subsonic all the way back to Taiwan, but Jim convinced me that everything was fine and that he clearly understood what had happened to him, although he had no real recollection of what had transpired during the 10-minute descent. Feeling comfortable that Jim now knew what was going on, I took the IFF out of emergency and he lit the burners and we flew supersonic to Kadena. One thing is for sure, you don't fly anywhere at Mach 3.0 and arrive at your destination 15 minutes late.

Col Minter and a few of the other SAO-watchers knew that something had happened, but no one knew what it was until the debrief (behind closed doors) when the problem was discussed in detail.

The initial rebuffs aimed at Jim soon gave way to more constructive dialogue when those who had not flown began to realize just how fortunate the crew of '974 had been. If Jim had not responded exactly as he had to Dave's instructions, the aircraft and crew would have vanished into the sea and the Habu loss may have remained a mystery. It was therefore agreed that no disciplinary action would be taken and the story would be suppressed (which it was, for 25 years).

As the experience of triple-sonic reconnaissance continued, crew changeovers brought other pioneers into the combat line-up at Kadena. In early May 1968, Maj Don Walbrecht and Capt Phil Loignon arrived to make their mark in operational flying. Their eight sorties from Kadena were typical of those flown at the time, and, in contrast to most of the initial missions flown in March and April, went quite smoothly. Like all crews, they started off with a two-hour training flight south of Okinawa in '976, on 19 May 1968, to get the feel of the vast oceanic area of the western Pacific.

Six days later they were airborne in '978 on their first North Vietnamese sortie, which lasted 5.25 hours. Completing the standard post-take off refuelling, they were determined not to abort their mission unless 'a wing fell off'. Back in the US, Don and Phil had experienced few inlet unstarts, but on their first important ops sortie while approaching Mach 2.4 and 55,000ft one of the inlets let its shock wave go with an almighty bang. Phil asked, 'Isn't that a mandatory abort item?' 'Isn't what an abort item?' replied Don. They pressed on to 75,000ft; the inlets kicked and bucked a few more times but all was smooth as glass when they arrived at Mach 3.0. After entering the Gulf of Tonkin, Don pressed on to Mach 3.2, which gave the Habu another 4,000ft above the SAM shooters.

Coasting in over Haiphong at 79,000ft, they cruise-climbed to 81,000, where Phil noted a SAM target-acquisition radar locking on. Immediately his ECM equipment nullified the

threat and no missiles were fired. After crossing Hanoi and flying close to China, they exited North Vietnam over Laos, where Don eased the throttles out of burner for his descent (well aware of O'Malley, Brown, Watkins and Devall's double flameouts). Immediately there was a low rumble (the onset of an inlet/airflow mismatch, which had probably caused the spate of flameouts). Instinctively, Don eased the throttles slightly forward, adding an additional 200RPM to the engine speed. The rumble instantly disappeared and the engines remained alight for a notably smooth descent.

Don accelerated and climbed '978, by now decorated with Playboy rabbit artwork, on a southerly heading, rounding South Vietnam for another northbound run. They charged back up the Gulf of Tonkin, offset from their first pass to make another uneventful run and a smooth deceleration at the slightly higher power settings, the mission terminating (after refuelling) in an uneventful recovery back to Kadena.

They were airborne again the next day, taking '978 on a functional check flight to verify inlet performance, and again on 8 June, in the same jet to maintain aircrew currency. They completed their second operational sortie in '974 a few days later, with a 4.5-hour 'single looper' over North Vietnam.

Their third mission was again in '978, on 30 June (a two-looper lasting 5.5 hours), for which they were each awarded the Distinguished Flying Cross. Don explained:

> Phil and I flew this important sortie in the face of a great typhoon, which was positioned off the southeast coast of Vietnam. It was extremely impressive to see from high altitude, easily visible from more than 500 miles away. Phil and I completed our two passes over denied territory and were heading back towards Kadena. By this time the typhoon had moved closer to the land mass of Vietnam and pulled a great deal of moisture into its system. It was a remarkable sight, this enormous boiling maelstrom of clouds stretching out before us, with vast columns of thunderstorms forced upwards on convective currents of air rising along its forward spiralling arms.
>
> The exceptionally tall storms looked like giant turrets guarding this mass of moving energy. Unable to see the storms that were lined up ahead of us, Phil was concerned that we might have to fly through the tops if they reached above 70,000ft. When we got closer we could see that we had the better of them by at least 5,000ft. Flying at Mach 3.0, 15 miles up, one rarely approaches any other object closely enough to feel the spectacular sensation of 'great speed'.
>
> The typhoon had acted like a giant vacuum cleaner, drawing moist air away from the land mass and into the storm. The result was high quality, clean air over all of the target areas, allowing us to obtain outstanding resolution of the 400 important targets Phil's cameras photographed.

Don and Phil were especially proud of having been able to provide such a high quality take, but they modestly maintained that it was just good fortune that they happened to be airborne on such a good day, and that any crew back at the OL could have brought home the 'goods'. Thanks to the typhoon, Vietnam, China and Laos were all unusually clear and they got the 'good-goods', which saturated the attention of photo interpreters at all national and theatre intelligence centres.

On their final ops sortie in their 'always-in-the-green' '978 on 23 July 1968, Don and Phil flew another important double-looper, lasting five hours. It yielded yet another superb quality take thanks to the proximity of 'the granddaddy of all thunderstorms', which squatted over Haiphong. Don explained:

Phil and I came zipping back up the Gulf clearly seeing all of Hainan and a great piece of China on our right. To our dismay, it appeared that too many clouds loomed ahead for a good run. I could see a great mass of high clouds standing over our target with a storm pillar billowing up out of its middle – it was the superdome of a single massive semi-tropical thunderstorm. I said to Phil, 'it looks as if our sortie is going to be ruined by all of the undercast.' We pressed on hoping for the best, accelerating and climbing to Mach 3.2 and 80,000ft to make the run. By the time we topped out, we were beginning to cross over the storm, just barely above it.

My attention was riveted on the billowing top, which must have extended up to 79,000ft – surely one of the highest cloud formations ever reported. We made a slight turn to the left to stay on track and went right over the top of the grand storm at an absolutely incredible rate of passage. Momentarily, I could feel the disturbing effects of the rising atmosphere's convective instability that made the Habu wallow around more than I'd ever experienced at that high an altitude. As we shot over the top of it, the landmass ahead was sparklingly clear with perfect visibility all the way to mid-China. Phil photographed all of North Vietnam and much of southern China, and we turned south over Laos descending on our usual tanker track near Korat, Thailand. Again, there were lots of medium-sized thunderstorms over Thailand, but we found the tankers right where they were supposed to be.

The tanker's boomer plugged into '978's receptacle immediately and the pilot started dodging all over the sky to avoid thunderstorms. It seemed we were heading west much longer than normal because of the sun's position and I recall looking out during a turn and asking Phil, 'What's all that water down there?' He replied that it was the Andaman Sea, near Rangoon in Burma. We finally headed back to the southeast and after filling our tanks I asked the tanker's navigator for a heading that would take us clear of the thunderstorms, to which he replied, 'There isn't one. You'll just have to take your chances.' We climbed and accelerated, luckily missing all the very turbulent thunder cells. After we got above 50,000ft and over the tops of most of the storms, we were in a continuous shroud of high thick cirrus, which extended to the mid-sixties.

We were moving at Mach 2.6 when we blasted from the cloud tops. It was like being shot from a rocket as we bolted from the high tropopause into the clear stratosphere. We did another fast circuit of North Vietnam to see that the great single storm had already entered the post-mature phase with its anvil top flattened out farther below. We then descended back into Thailand where the other storms had been. We were pleased that they had softened and moved further west. Having completed our third refuelling, we raced back to Kadena for an uneventful landing. We flew our final Kadena training sortie, again in '978, shortly afterwards and redeployed back to California in the weekly Beale tanker.

At just after 9:00am on 26 July 1968, Maj Pat Halloran and his RSO Maj Mort Jarvis launched in '974 for what was to be their first operational sortie. However, during the course of conducting a bit check on their DEF suite, Mort detected a systems failure. Since this was a No-Go item on the check list, he continued to recycle the equipment in the hope that the problem would clear, but to no avail. With time running short, the crew finally had to admit defeat and literally just five minutes short of their mandatory time to call for the spare to launch, they had no option and made the abort call.

Consequently, at 10:08am Maj Tony Bevacqua and Maj Jerry Crew launched in '976 to replace Pat and Mort on the planned double-looper over the North. On their first pass, Jerry

▲ The diagonal white exhaust trail across this frame taken from '976's TROC marks the path of an SA-2 fired on 26 July 1968. (USAF via Tony Bevacqua)

▶ Majors Tony Bevacqua (left) and his RSO Jerry Crew had the dubious distinction of being the first SR-71 crew fired upon by SA-2s. (USAF)

warned Tony that a SAM fire-control radar had locked on to them. Almost immediately he said, 'We've been fired upon'. The defensive systems performed as advertised, but Tony was unable to see the missiles, which ended up well behind them.

During refueling, Jerry asked Tony if he intended to complete the sortie, since their next track would take them right back over the position from which they were fired upon. Tony replied, 'Why not? They missed us.' On the next pass there was no reaction from any SAM battery. Back on the ground at Kadena, Tony recalled, 'As we got out of the aircraft we knew the commander already knew about the incident. The first thing he asked was, "Did you see anything?" We said we hadn't, but we knew that it was for real. We were later told that the nearest of the two missiles was about one mile away.'

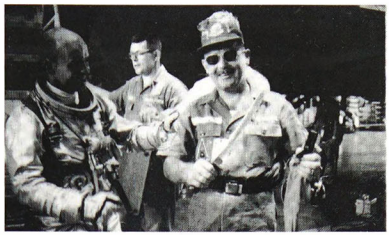
It was the first occasion that an SR-71 had definitely been fired upon and, by chance, the terrain-tracking camera took a picture of the SA-2s, recording Tony's 'first' for the record books.

Pat and Mort launched in '974 two days later and completed their first ops sortie, a 5.3hr flight, flawlessly.

TRADITIONS AND ANTICS

All work and no play makes John a dull boy, so the saying goes. Habu crew certainly knew how to work and get their job done, and they most definitely could not be accused of being dull, especially John Storrie, Buddy Brown, Larry Devall and some of the more notorious pranksters. There was usually a genteel Sunday afternoon daiquiri party in the commander's quarters, which were only about 100 yards from the 'O' club (Officers' club) where many evening activities began.

The favourite brew of one party group was 'Velvet Punch', so-called because it could knock you out gently. Craven Gibbons (a tanker pilot of Habu renown) was the undisputed master brewer of this 'smoothly lethal concoction', whose main constituents were three parts concentrated frozen lime juice, two parts beer and one part Everclear. Light yellow/green in colour, Velvet Punch was mixed in a stainless steel bowl liberated from the kitchen. For the benefit of visitors, a clean jock and a pair of athletic socks were added. The stainless steel 'tanker bowl' was refuelled throughout the night until there was no one left capable of restocking it.



◀ Major Don Walbrecht has his necktie cut by CMSgt Gornick wielding a miniature samurai sword after successfully completing his first operational mission over North Vietnam in '978, on 25 May 1968. (USAF via Don Walbrecht)

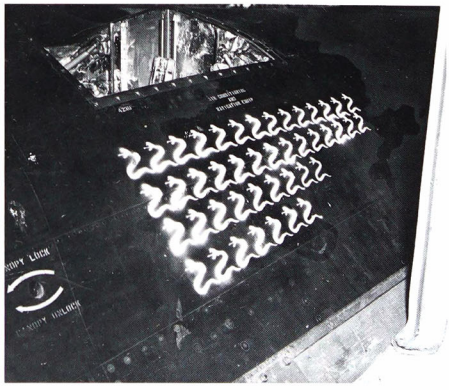
At the south end of BOQ 310 (the Habu home away from home) was a kitchen where the crews had their pre-flight meal. Next to the kitchen was Doc Malley's room, where crews received their pre-flight physical exam. The Habus (under Buddy's leadership) convinced the Doc to give up his office for a crew lounge. They quickly set to work blanking out the entrance door and cutting an entry door into the now isolated room through the kitchen's broom closet. A proper bar, fancy light fixtures, music system and refrigerator were added, and the walls padded. The bright red decor of the 'Secret Bar' would have been more appropriate in a bathhouse. After the party room's reputation spread it became the envy of non-members, one of whom told the base commander, who would not tolerate Habu high jinks.

Intelligence gathering was, of course, OL-8's raison d'être, so it was not surprising that the Habus learned of the impending visit before the actual inspection. The Secret Bar was quickly and quietly dismantled one night, the old entrance was reopened and the room returned to its former state. When the base commander conducted his 'surprise' visit the next day, he was surprised he could not find what had been reported. Soon after the inspection, the room was again transformed into the Secret Bar and it was business as usual.

Partying with the Habus was great fun and in no time they were frequented (on John Storrie's leadership) by transiting airline crews who passed through Kadena on their way to and from Vietnam and Thailand, and by some of the unattached civilians who worked on base. One scatty blonde was given a meteorological nickname of 'High-Thin-Scattered', while another woman, with a narrow shaped, longer than average face and nose was known as 'Hangar Doors', because the 'giver of nicknames' thought that she had been caught between them at some point in the past.

On the night of 29 May 1968, the Habus held a dinner at the Kadena Officers Club honouring Col Bill Hayes (the White Tornado), who had just completed his 30-day tour as OL commander and would return to Beale on the transpacific tanker in a few days. After dinner the party moved into the less formal Stag Bar, where Chief Master Sergeant Bill Gornick and two other senior NCOs crashed the party to say farewell to the colonel. Amid much hilarity, Bill Gornick produced a penknife and severed the neckties of Bill Hayes and all the Habu crew members. The next day he mounted the ties on a guide-on flagpole, just like the battle streamers on a command standard, or the feathers on an Indian ceremonial pole. A new tradition had been born.

▼ Habu operational mission tallies soon mounted, especially during the Vietnam War. (USAF)



In response, Don Walbrecht and Phil Loignon purchased a miniature Samurai sword and took it on a Mach 3.2 Hanoi flight before presenting it to Bill Gornick, the 'Chief Master Necktie Cutter'. Thereafter, all crews flying their first operational mission from Kadena would wear a necktie inside their pressure suits. On completion of their sortie, they would emerge from the cockpit and have their tie ceremoniously cut off by Chief Gornick. Approximately 300 aircrew neckties, all properly embroidered with names and dates, and hanging from Bill Gornick's 'Command Standard', which dates from 30 May 1968, were put on display at Beale's Habu museum.

GLOWING HEAT

By the late summer of 1968, airframes '974, '976 and '978 had each amassed close to 300 flying hours at Okinawa. In so doing, they had easily validated the concept of long-range, triple-sonic, high-altitude strategic reconnaissance within hostile airspace. Their sensor systems had acquired intelligence data of national significance that had directly influenced the conduct of many air and ground operations. The dedicated professionalism of the maintenance teams working for Col Estes, and the high quality systems maintenance done by specialist company technical representatives, kept these deployed aircraft in top condition, but there were certain heavy depot-level maintenance tasks that lay beyond the capability of OL-8.

For deep maintenance and tech-order modification work, the original three aircraft had to be returned to Lockheed's Palmdale Plant 42. A complex every-other-day swap-out exercise code named Glowing Heat was effected in late September, with '974, '976 and '978 being replaced by '962, '970 and '980. These aircraft were similarly replaced in April 1969 by '971, '975 and '979.

Newly promoted Lt Col Tony Bevacqua and his new RSO were participants in a Glowing Heat deployment from Beale to Kadena in '974, in September 1969. They had just completed refuelling in the vicinity of Midway Island when one of the 'generator-out' lights illuminated on the telelight annunciator panel. It was a mandatory abort item, so they dumped much of the fuel load that had just been taken on and diverted into the tiny atoll.

Although Midway is a renowned breeding ground for the albatross, the population of these large birds had left the island a few days prior to Tony's arrival, and he landed without incident (the birds often rested on the runway and were often hit by landing aircraft). Since Tony had led off the deployment, he was stuck on the island until the other Habus had been exchanged. A recovery team then came over from Kadena to solve their problem, as Tony explained:

> The place was all Navy. Our BOQ was a cement-block building with no air-conditioning and equipped with the world's most uncomfortable beds. To make matters less tolerable on this tiny island in the middle of nowhere, the 'O' club didn't open until 1600 hours and we had to sit it out there on 'the rock' for ten days while our friends were laying sonic booms on us as they shuttled their Habus back and forth across the Pacific. While there though, I had the pleasure of meeting Judy Sides, a nationally recognized and respected artist of the Gooney Bird [albatross].
>
> By the time '974 was ready to complete its trip to Kadena, she had painted a Gooney Bird symbol on each wheel well door, applied another to each of the tails and another on the left side of the fuselage, near the cockpit where the white Habu-snake mission symbols were normally painted.

This short-lived artwork won the approval of the Habus at Kadena, and constituted a new kind of 'first' in aviation art.

Escalation of the Vietnam War generated an increase in the demand for timely, high-quality reconnaissance imagery. OL-8's SR-71 establishment was therefore increased in the spring of 1970 from three to four aircraft ('969, '972, '973 and '974). In many ways the next three years would prove to be the detachment's golden era.

MISSILES

On 20 September 1968, Maj Dale Shelton and Maj Larry Boggess completed their first operational sortie in aircraft '980. However, 30 minutes into their second operational flight on 4 October they were just approaching the KC-135 to top off after take off when a coded message came through on HF radio from Sky King, SAC's Giant Talk network, telling them to abort their mission and return to Kadena.

Larry checked the authenticity of the message, but could not retransmit on HF since Dale had already started refuelling. Larry recalled, 'When we didn't answer immediately, we got a curt UHF radio call from the Kadena command post asking us if we'd received an earlier HF message transmission. We disconnected from the boom, dumped some fuel and recovered aircraft '970 back to Kadena.' It seems intelligence sources had discovered that the enemy knew of the Habu's intended route, which would take the jet directly over the top of an active SAM site. Although SR-71s had been fired upon on an earlier sortie, it was deemed the Vietnamese had too much of an opportunity on this occasion.

With a full-scale war raging in South-East Asia, more and more crews had their chance to get a first TDY at Okinawa, which was proving a great place to fly the Habu from because it was far more secure than other bases in the region. Maj Bobby Campbell and Maj Jon Kraus flew their first sortie over Vietnam on 21 November 1968, a double-looper flown in '970 that lasted 5.5 hours.

Maj Bob Powell and Maj Bill Kendrick flew their first ops sortie in '980 on 29 December 1968 (again a double-looper lasting almost 6 hours), in which they were fired upon by two SA-2s. They brought back an especially high quality take by flying straight through their target run despite rising missiles. They each earned a Distinguished Flying Cross for the mission. One Habu driver later remarked to the author:

> Flying an SR-71 over the war at eighty-odd thousand feet was almost unreal. The Thud drivers were right down there in the middle of things while we were passing high overhead safely out of reach of the Soviets' best weapons. On a clear day, you'd see (and hear) the war going on 15 miles below.
>
> We could sometimes see flashes of fighter aircraft charging about and could often hear the excited radio conversations on guard channel, especially if an aircraft was down. We were only at risk for 15 minutes on both passes because we could cross North Vietnam in less than eight minutes flat. We always knew, however, that we'd really be in for it if we ever had to bail out over enemy territory, for we would certainly have been a propaganda prize in our silver moon suits. We also had the advantage that in just a few hours we could be several thousand miles away back at the Secret Bar sipping a glass of Chivas Regal.

Some of the crews who were fired upon by SA-2s spoke of seeing the SAMs through the RSO's view sight and the pilot's rear-view periscope. The missiles had to be fired 30 miles ahead of the jet to achieve the SR-71's altitude by the time it arrived. Two white trails would appear well ahead of the Habu, but were normally not seen by the pilot since the aircraft's nose blocked his ground view ahead. As the missiles approached, the RSO could see them rising by looking through his down-and-forward-looking viewscope.

When the missile exploded (usually above and behind) the pilot could get a quick glimpse of the explosion, which would first appear to billow out and then implode on itself. That visual effect came about because of the rate of speed at which the jet raced away from the

▲ Pictured at Beale, '969 was lost on 10 May 1970, near Korat, following a subsonic high-speed stall. (Lockheed Martin via Tony Landis)

point of detonation. It was very strange to see, but the crews reported that it was also very comforting to know that the SAMs were ineffective because of the very long firing lead the missile shooters needed to boost the SA-2 to altitude to point-intercept their 3,000ft/s target.

AIRCRAFT LOSS

Throughout the early 1970s, OL-8's Vietnam sortie rate averaged two flights per week. The nature of high-speed flight insured that those combat sorties would never become 'routine to the point of indifference'.

OL-8 lost its first Habu after more than two years of Kadena operations, which included more than 200 operational and training sorties. On 10 May 1970, Maj Willie Lawson and Maj Gil Martinez had completed one pass over North Vietnam and refuelled '969 near Korat RTAFB. Willie had initiated an afterburner climb to prepare for a transonic dipsy-doodle. But thunderstorms had rapidly built up across Thailand; no matter where they looked, a solid bank of cloud enshrouded the heavy thunder cells, which towered up to 50,000ft.

Even an SR-71 needed climb distance to get above the clouds, and the dip manoeuvre gave the aircraft a head start on achieving the airspeed and Mach needed for a higher rate of climb. The 0.90 Mach preliminary climb was sluggish with a full fuel load, and Willie eased '969 into a slightly steeper climb to zoom up over the notch of a 30,000ft saddleback of connecting clouds between vertical storms in order to stay clear of the cells ahead. At that moment, the aircraft entered turbulent clouds and both engines flamed out.

▼ Majors Willie Lawson (right) and RSO Gil Martinez ejected safely from '969. (USAF)

In severe turbulence, without engine thrust, the aircraft's angle of attack increased. Suddenly the nose rose up into the dreaded pitch-up from which there was no recovery. Both crewmembers ejected safely and landed in the vicinity of U-Tapao. Resplendent in their silver moon suits, they recruited the aid of a Thai who was driving a *saamlor* (a three-wheeled vehicle common to Thailand) and were driven back to U-Tapao and then flown back to Kadena in a KC-135. On their arrival, Col Hal Confer (the Det commander) and the entire unit had gathered to welcome them. It was sad to lose a trusty Habu, but great to get the crew back. Overall, the pitch-up problem cost four aircraft in the 26 years of the SR-71 programme.

MORE IMPORTANT SORTIES

Flying time in the SR-71 (especially combat flying) was always considered a premium commodity among the 20 crews, who would wheel-and-deal with the staff schedulers for additional sorties. Although South-East Asian sorties accounted for the majority of OL-8's flight hours, that area was not the exclusive domain of the Habu.

Majors Bob Spencer and Butch Sheffield were particularly pleased to be selected for a prize sortie on the night of 27 September 1971. After completing the ritual post-take off air refuelling in '980, they climbed away from the tankers on a northerly track opposite to the standard route south into Vietnam. US intelligence had obtained details of the largest ever Soviet naval exercise, to be held near Vladivostok, in the Sea of Japan. Undoubtedly, such an event could provide a rich source of intelligence data, and an SR-71 was the ideal vehicle with which to stir the Soviet fleet's defense systems into action.

National security officials were especially interested in obtaining fresh data on the signal characteristics of the Soviets' new SA-5 SAM system, code named "Gammon". If details including its radar's frequency, modulation, PRF, pulse repetition interval (PRI) and other factors could be measured, it might be possible to develop an effective ECM device to reduce or even negate the SA-5's highly-touted capabilities.

But there was a problem in that the various ELINT recorders carried on the SR-71 filtered the vast range of electromagnetic emissions transmitted from all sources and actuated special recorders when receiving only certain signal types – the continuous-wave signals, including those emitted by the SA-5, were not among them. Major Jack Clemence (an inventive electronic warfare officer), who worked in the 9th SRW's Electronic Data Processing (EDP) Center, jury-rigged one of the ELINT sensors by electronically cutting and splicing the pulse receiver's filtering system, which allowed it to receive a continuous-wave signal.

The possibility of night disorientation (caused by inlet unstarts and other hazards) over the dark northern Pacific led the mission planners to restrict most turns to a 25° bank limit while night flying at Mach 3.2. The two crewmembers of '980 concentrated their attention on the naval target area just off Vladivostok while slicing through the night in full afterburner. If they maintained their current inbound track toward the Soviet port and turned at a 25° bank, they would overfly the USSR, crossing high over the Khrebet Sikhote Alin, and exit the area into the Sea of Japan before returning to Kadena.

As they bore down on the target area, dozens of Soviet radars were switched on to record what appeared to be shaping up as a certain violation of sovereign Soviet airspace. The deception worked well, as '980 turned at the precise moment and failed to violate Siberian airspace having been programmed to roll into a full 35° bank instead of the previously recorded 25°, thus remaining international airspace.

On their approach to the target area, Bob noted to his great dismay that the right engine's oil pressure was dropping. Nevertheless, he pressed on. They had completed their target run and were heading south towards home plate when he rechecked that critical oil pressure gauge. By then, its reading had fallen to 'zero', which was bad news indeed. After a brief consultation with Butch, he shut the engine down. Having already stirred up a hornet's nest of defence activity with their feinting pass over the Soviet Pacific Fleet, they were now forced to descend and continue the rest of their flight at subsonic speed, where they would be sitting ducks for any fast jets that might be scrambled to intercept the oil-starved Habu. To make matters worse, they encountered extreme headwinds that rapidly depleted their fuel supply. Butch calculated that a recovery back to Kadena was completely out of the question. Instead, they would divert into South Korea.

The OL commander had been monitoring '980's suddenly slowed progress and as the Habu neared Korea, US listening posts reported the launch of several MiGs from Pyongyang, North Korea, on what appeared to be an intercept attempt. USAF F-102 Delta Daggers were immediately launched from a base near Hon Chew, South Korea, and vectored into a position that put them between the MiGs and the SR-71.

It was later established that the MiG launch had been unconnected with the Habu's descent. Bob recovered '980 into Taegu, South Korea, where the base commander had already received a call concerning his special visitor and was ready to receive the SR-71 and its crew. Their EMR take turned out to be 'monumental'. In all, Bob and Butch had sniffed out emissions from 290 different radars. Of even greater significance to Western intelligence analysts were the 'beautiful' SA-5 signals they had captured – the first ever detected by Western observers.

MPC'S BLUE BOXES

On 5 April 1972, Lt Col Ed Payne (by then OL-8's chief of intelligence) received a phone call from a friend at Norton AFB, California, who spoke in indirect references about 'some blue boxes that would soon make Ed's job easier'. The call was so obscure that he did not know what his Norton contact was trying to tell him until a week later, when he received a top secret message. The president had just signed the Defense Appropriation Bill, within which provision had been made for the OL to be equipped with a mobile processing centre that could perform post-mission processing at Okinawa rather than having to send the material to Japan or the US.

The computer portion of Mobile Processing Center I (MPC I), contained in eight 8×8×40ft 'vans' (similar to modern shipping containers), had been dispatched from Beale to Kadena in time for the arrival of the first three SR-71s deployed to the island in March 1968. Contained within these was the CDC-3200 computer equipment needed for SR-71 mission planning, programming the aircraft's sensors and providing an initial scan of the SR-71's ELINT collection. The remaining 15-van portion contained equipment necessary for processing the SR-71's HRR and photo-reconnaissance collections and for preparing a detailed analysis of the aircraft's ELINT collection – these were airlifted in by two Military Airlift Command (MAC) C-5 Galaxys. The AGT-30 Adage Graphics Terminal was shipped aboard a MAC C-141 StarLifter from Travis AFB.

Just before the arrival of Ed's Blue Boxes, an area at Kadena was rapidly prepared for them. The blue vans were quickly unloaded and moved to the newly prepared area, where they were interconnected to function as an in-theatre recce-tech unit. At 18:45 on 18 April, Ed was on the phone to the NPIC informing them that he was ready for quick-response intelligence processing.

The OL could now process ELINT, COMINT and black-and-white imagery. With the MPC up and running, imagery was fast processed as soon as the Habu landed, and 'wet-read' by the photo interpreters who supplied an Initial Photographic Intelligence Report (IPIR) on the highest priority targets. Before the MPC was deployed, SAC flew the SR-71 film to the 548th RTG at Hickham AFB, Hawaii for processing and a preliminary readout, a process that took on average 40 hours. With the MPC in operation, this was cut to 11 hours.

This intelligence would be communicated in plain English on a secure telephone to appropriately cleared persons on Henry Kissinger's staff who could, if necessary, provide a report to the president within four hours of an SR-71 overflying key targets. Such direct reporting of hot intelligence was considered 'a remarkable achievement' for the time. Duplicate sets of negatives were immediately produced, with a set being flown to Eielson AFB, Alaska,

▲ SR-71A '976 undergoing final pre take-off external checks by ground technicians and the aircraft's crew chief. (Lindsay Peacock)

where it was transferred to another courier aircraft and flown to Washington, DC to be sped onward to the NPIC. Another courier would deliver a set of negatives to the 12th RTS at Saigon for the next day's air strike planning. Other high-priority recipients were: (1) Fleet Intelligence, Pacific (FINPAC); (2) the 532nd RTS at Udorn RTAFB; (3) the 544th RTS at Offutt AFB, Nebraska; (4) SAC's B-52 force in South-East Asia; (6) the DIA; (7) the JCS; and (8) the president and National Security Council.

The MPC also accomplished an initial ELINT scan for high-threat signals within 3 hours after the SR-71 had returned. The complete Mission Intercept Report Electrical (MIRE) was produced in 20–24 hours, but final follow-on technical ELINT reporting was still conducted by the 9th RTS at Beale.

POWS

US aviators first became prisoners of war (POWs) of the North Vietnamese in 1964. History would later bestow upon several of them the dubious honour of being the longest-held US captives of any conflict to date.

On 18 July 1965, Commander Jerry Denton was shot down and captured by the North Vietnamese while flying an A-6A Intruder from USS *Independence*. Fiercely adhering to the six articles within the POWs' Code of Conduct, he was tortured for ten months, repeatedly beaten and forced to appear in a propaganda broadcast. Pretending to be blinded by the TV crew's spotlights, Denton began blinking, seemingly random spasms and tics. In fact the brave pilot blinked out in Morse code 'T-O-R-T-U-R-E'. The film, made by a Japanese crew, was broadcast on American television on 17 May 1966, and was the first confirmation that US POWs were being subjected to atrocities. When the North Vietnamese realized what Denton had done, he was severely beaten in his cell for days.

On 9 September 1965, while flying A-4E 151134 off the deck of USS *Oriskany*, Cdr James Stockdale was shot down and imprisoned in Hoa Lo, Hanoi. Originally built by the French when Vietnam was one of its colonies, this notorious prison was renamed 'the Hanoi Hilton' by its US inmates. Stockdale was a senior POW and like Denton conformed rigidly to the Code of Conduct; he was singled out for regular beatings.

Notwithstanding, he played a key role in establishing a highly effective covert system of inter-prisoner communication, even when individuals were placed in solitary confinement, and became head of the prisoner escape committee at Hoa Lo. He used 'double-speak' in

▲ During the course of a 5.5-hour mission in '973 the day after Operation *Kingpin*, Majs Dave Fruehauf and Al Payne secured extremely good-quality imagery of the camp. (USAF)

letters home to his wife and she realized he was sending her coded information about the POW camp and its conditions, and took the letters to Cdr Donn T. Burrows at the Office of Naval Intelligence (ONI). She bravely agreed to play a vital role in establishing a covert two-way communications link via the couple's letters. This delivered important information about the condition of Hoa Lo's inmates and other intelligence to the ONI, and enabled it to get information back to Stockdale.

When Capts John Dramesi and Edwin Atterberry managed to escape from the Zoo Annex, a POW camp near Hanoi, on 10 May 1969, only to be recaptured 12 hours later some three miles away, the repercussions for all the POWs were extreme. Convinced that others must have been involved in supporting the breakout, the prison authorities unleashed an orgy of unbridled sadistic cruelty. The two escapees were tortured and beaten for 38 days, Atterberry dying as a result. The beatings were then extended to many of the POWs incarcerated in a dozen facilities throughout North Vietnam. As a result, captured senior officers implemented a slight revision to the Code of Conduct, whereby further escape attempts wouldn't be sanctioned unless external help was available, thereby ensuring a greater chance of overall success.

On 10 June 1970, a feasibility study group was convened by the Special Assistant for Counterinsurgency and Special Activities (SALSA), code named Polar Circle, to look into the possibility of springing the 61 POWs believed to be at the Son Tay camp, located about 23 miles West of Hanoi. A training, planning and development group code named Ivory Coast was established on 8 August to review reconnaissance imagery provided by Teledyne-Ryan Buffalo Hunter reconnaissance drones and SR-71s. The low-flying drones were used sparingly over the target area for fear of alerting the North Vietnamese to the possibility of a raid. However, flying at extreme altitude and using its Tech or panoramic cameras, the SR-71 was an ideal platform for obtaining high-resolution photos of the camp without drawing unwanted attention.

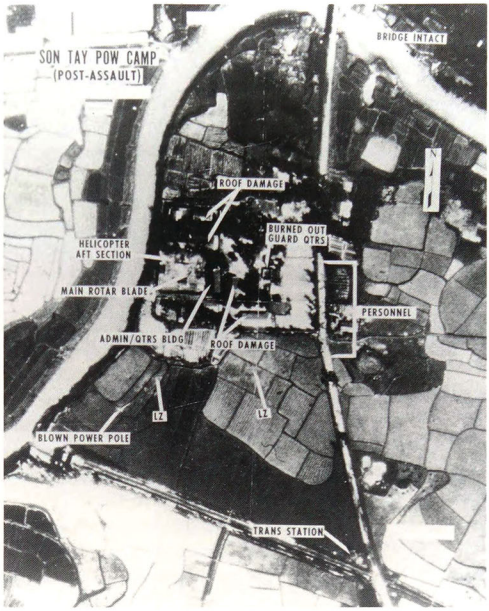
In the last ten days before the planned raid, intense reconnaissance efforts were conducted, but every attempt was thwarted by poor weather. Continuous cloud cover concealed Son Tay from the Habu's high-altitude cameras, and two drones never returned. Nevertheless, Operation *Kingpin*, the bold raid to rescue the POWs, was mounted in the morning darkness of 21 November 1970. It employed 56 US special forces troops, deployed in five HH-53 Super Jolly Green Giant helicopters, and included 23 other direct support aircraft.

However, after an eight-minute firefight in which between 50-100 North Vietnamese Army guards were killed, it was discovered that the inmates had been moved to another camp

(Dong Hoi, 15 miles further east) a few days prior to the raid. Various reasons for the move have been given, including contamination of the camp's well due to flooding and the beginning of a major relocation of all POWs from outlying camps to those located in and around Hanoi.

There's little doubt that the lack of detailed, timely photo-intelligence was a key contribution to *Kingpin* failing to achieve its primary objective, as was excessive compartmentalization, which denied the planners access to a 'bigger intelligence picture'. However, most returning POWs after the war reported that as a result of the Son Tay raid, their treatment and conditions improved.

By 1972, it has been reported that covert communication into Hoa Lo had become possible by the limited use of a radio, infiltrated into the prison by the CIA. A plan formulated by Capt John Dramesi to escape with a fellow POW between 1 and 15 June, steal a boat and travel down the Red River to the Gulf of Tonkin, where they could be rescued by a team of US special forces was communicated to the camp's senior ranking officer (SRO). Once approved, it was communicated to the ONI and then escalated to the very top of the chain of command – the commander-in-chief, President Richard Nixon, who also approved the audacious plan.

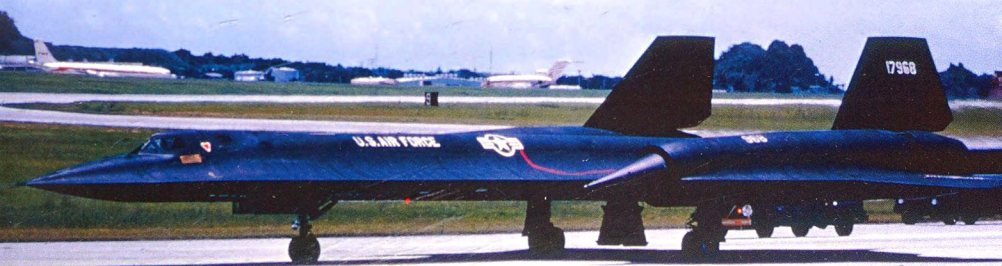


▲ Pre-strike reconnaissance image of the POW camp at Son Tay taken by an SR-71's Tech camera. (USAF)

In April 1972, the submarine USS *Grayback* (LPSS 574), under the command of Cdr John Chamberlain, slipped its moorings at Subic Bay, Philippines and put to sea. On board was US Navy SEAL Team One and Underwater Demolition Team 11 (UDT-11). The plan, Operation *Thunderhead*, developed by Lt Cdr Edwin Towers, the officer in charge (OIC), involved the SEAL team infiltrating an island in the Red River estuary using underwater swimmer delivery vehicles (SDVs). From there they'd provide surveillance, which would be enhanced by up to four flights per day of a wider area conducted by HH-3As from Detachment 110, Helicopter Support Squadron (HC-7), from USS *Midway*. To cover Dramesi's escape plan, the operation was to be run from 29 May to 19 June.

To ensure that the POWs directly involved in Operation *Thunderhead* were fully aware of the CinC's approval of the plan, a unique covert signal was devised – two tri-sonic booms, exactly 15 seconds apart, would ring out over Hanoi on 2 and 4 May. To generate this 'sound

▼ SR-71A '968 flew during the 2 and 4 May 1972 missions to boom the 'Hanoi Hilton'. (Via Lindsay Peacock)



of freedom', the services of two SR-71s would be required. However, since the mission was so critical, a third airborne spare would also be launched as a hedge against any last minute mechanical problems that might interfere with the signal's timing.

At precisely 14:16 on 2 May 1972, Maj Bob Spencer and Maj Butch Sheffield were airborne in '979, followed just two minutes later by Lt Col Darryl Cobb and Maj Reggie Blackwell in '980. At 15:22 Maj Dave Fruehauf and Maj Gil Martinez launched in '968. The missions recovered back into Kadena with '979 having logged 4.8 hours, '980 clocking up 3.8 and '968 clocking 4.1.

On 4 May, Majs Tom Pugh and Ronnie Rice approached Hanoi in aircraft '968 at 75,000ft from the south, while Majs Bob Spencer and Butch Sheffield maintained 80,000ft in '980 and flew across the target from the south-east. Meanwhile Lt Col Darrel Cobb and Maj Reggie Blackwell were the airborne spare in '978; they were to cross the 'Hilton' at 70,000ft from the west should either of the primary aircraft have to abort. When the pre-arranged code word was transmitted, Darryl broke off his run short of the target area.

Both missions were termed 'entirely successful' and accomplished their objective within the very tight time constraints, while reconnaissance gathering was of secondary importance to the signal. Unknown to the planners on the 'outside', however, there was a major issue with the SRO in Dramesi's room, who'd become aware of the plan. Despite the escape committee having determined that the plan had a 90 per cent chance of success, he'd gone to the camp SRO and reminded him of the repercussions felt by the rest of the POWs after Dramesi's and Atterberry's earlier escape attempt. The appeal caused the camp SRO to reverse his earlier decision. He withdrew permission to conduct the escape and ordered the escape committee to stand down. Since there weren't the means to communicate this decision quickly enough, Operation *Thunderhead* was launched regardless. It was eventually called off after a number of mishaps, one of which resulted in the death of Navy SEAL Lt Melvin Spencer Dry.

A CLOSE CALL

On 15 May 1972, Majs Tom Pugh and Ronnie Rice were airborne in '978 on Tom's 236th SR-71 sortie. They were flying a routine Giant Scale mission, scheduled to be a double looper up through the Gulf of Tonkin for a front door entry. Just short of Haiphong, Tom's concern over a strange cyclical hum in the interphone system was relieved when the generator bus tie circuit split, allowing independent operation of each of the 60 KVA AC generators, one of which had been responsible for the varying frequency, hence the hum.

Freed of the AC bus load sharing, the system seemingly returned to normal. The Go-No-Go checklist allowed the mission to proceed. While Tom was maintaining Mach 3.18 at 79,500ft, a generator failed. That failure was a mandatory abort item, so the crew began making provisions to divert into Thailand.

Just over a minute later the other generator failed, and they were in real trouble. Emergency AC and DC power did not come online and the fuel boost pumps stopped pumping JP-7 to the engines. Without electrical power, the SAS cut out, and lacking boost pump pressure the fuel flow to both engines stopped, causing them to flameout. To add to the crew's grief, the inlet spikes went full forward and, as '978 began pitching and rolling rapidly, Tom knew the aircraft was approaching the limits of its supersonic flight envelope.

Tom instructed Ron to 'get ready to bail …', but the intercom system failed before he could finish the statement. He held the stick gently while struggling to control the jet (without causing further pilot-induced oscillations), and while also trying to reach the all-important 'standby electrical switch' located on his right-hand panel. To reach that critical switch, he had

to move his left hand off the throttles and on to the control stick in order to free his right hand so he could restore some electrical power to the aeroplane. This accomplished, Tom initiated a gentle 'needle ball and airspeed' turn towards a 'friendly piece of concrete'. Having descended to 41,000ft and slowed to just Mach 1.1, he managed to get one generator back online and both engines relit. He then reaccelerated '978 to Mach 1.7 to exit the area as quickly as possible. Tom crossed Laos to recover '978 into Udorn RTAFB without further problems.

▲ Majors Tom Pugh (right) and RSO Ronnie Rice overflew Hanoi in '978 at just 41,000ft on 15 May 1972. They got away with it and diverted into Udorn RTAFB. (USAF)

The serious nature of the malfunction necessitated a subsonic return to Kadena even after repairs had been made. As they set off with two tankers (one carrying the recovery team), they heard another SR-71 diverting into U-Tapao RTAFB. The tanker with the maintenance team peeled away from '978 and headed back to Thailand to recover the other aircraft. At their post-flight analysis, Tom and Ron learned that they had overflown Hanoi at 41,000ft.

They had been extremely lucky, considering the number of SAMs that encircled the city. It appeared that the Vietnamese radar operators and their Soviet advisers had been 'asleep at the switch' during '978's mid-altitude pass over one of the best-defended cities in the world. The 'Bunny' had pulled off a lucky escape from what appeared to be an easy shootdown situation. Two days later, '978 had been repaired and the two intrepid aviators returned the aircraft to Kadena. Tom and Ron were each awarded air medals for meritorious achievement in 'the successful landing of their disabled aircraft'.

On 30 May, '978 was at the centre of yet another scary episode. Majors Bob Powell and Gary Coleman were approaching Hanoi in a front door entry when the SAS failed. They had just entered a 30° bank at Mach 3.2 and 81,000ft when the aircraft started porpoising. As Bob struggled to master the destabilized flight characteristics, he found that he had to decelerate and descend to where the aircraft would be more manageable. Gary radioed the tanker with a delayed rendezvous time because they would be approaching at subsonic speed. Bob completed a somewhat ragged aerial refuelling and trailed a spare tanker to the east coast of Vietnam, where they filled the tanks and slogged their way back to Kadena at 0.9 Mach (logging 6.5 flying hours).

FAREWELL TO THE 'BUNNY'

On 20 July 1972 the 'Rapid Rabbit's' luck finally ran out. While returning from an operational mission, Majs Denny Bush and Jimmy Fagg approached Kadena to learn of excessive crosswind landing conditions. On touchdown, Denny deployed the aeroplane's large braking parachute in a rapid deploy jettison technique to prevent '978 from weathercocking sharply into the wind and running off the side of the runway.

Unhappy with the first touchdown, he jettisoned the 'chute, pushed up the power, and 'took it around' for another landing approach. Although he successfully touched down on the second attempt, the crosswind was so strong that he was unable to keep the weathercocked aircraft on

▲ On 20 July 1972, SR-71A '978, widely known as the 'Rapid Rabbit', was written off following a landing accident at Kadena. It is seen here before disposal, stripped of engines, ejection seats and avionics. (Via Tony Landis)

the runway. During the off-runway landing rollout, one set of main wheels struck a low concrete structure, severely damaging the landing gear and causing substantial additional damage to the aeroplane. Both crewmembers clambered out unscathed, but '978 was written-off. The bits that were salvageable were transported back to Norton AFB in a C-5 Galaxy and used as spare parts for the other SR-71s. The remaining sections of the airframe were scrapped in Okinawa.

HABU SUPPORT OF B-52S

The flexible response strategy adopted by the Kennedy administration to fight the Vietnam War caused SAC to examine the tactical potential of its strategic bombers in the conflict. By mounting multiple-ejector racks on the wing missile pylons of certain B-52Fs, a further 24 bombs could supplement the 27 bombs that could already be hauled internally, almost doubling the bomb load.

As the situation in South Vietnam worsened, the JCS decided to deploy the modified B-52Fs to Andersen AFB, Guam, in February 1965. Under the code name Arc Light, the aircraft could be used to strike targets in North Vietnam in reprisal for terrorist action against US personnel in the south. Soon after an ineffectual bombing raid by a large number of fighter-bombers against Viet Cong base camps near Black Virgin Mountain on 15 April 1965, General Westmoreland obtained permission from Secretary of Defense McNamara to use B-52s in support of tactical operations in South Vietnam.

The first big strike took place on 18 June 1965, when 30 B-52s flew a 12-hour/5,500-mile round trip from Guam to the Ben Cat Special Zone in Binh Duong Province northeast of Saigon. As these Arc Light sorties continued, a modification programme known as Big Belly got under way back in the US. Between December 1965 and September 1967, 82 B-52Ds received new radar transponders for ground-directed bombing, and bomb bay and pylon modifications that increased their carrying capacity to a staggering 108 bombs weighing 81,000lb.

On 1 April 1966, the 28th and 454th Bombardment Wings deployed to Guam and began flying regular Arc Light sorties. In addition to the great increase in firepower that these Big Belly bombers represented, the sortie rate was increased from 450 to 600 flights per month. Seven Combat Skyspot radar-directed bombing ground sites were established, the first coming on line at Bien Hoa in March 1966. These sites, working in conjunction with the B-52s' new radar transponders, helped to improve bombing accuracy.

On 11 and 27 April 1966, B-52s struck North Vietnam for the first time, hitting targets in the Mu Gia Pass, which was the keystone of the notorious Ho Chi Minh Trail's supply network. The B-52 sortie rate increased as the ground war continued to deteriorate, and by

February it had reached 800 flights per month. Meanwhile, Guam had reached its saturation point in regards to the number of B-52s that it could support. Thereafter, additional aircraft were deployed to U-Tapao RTAFB at Sattahip, Thailand.

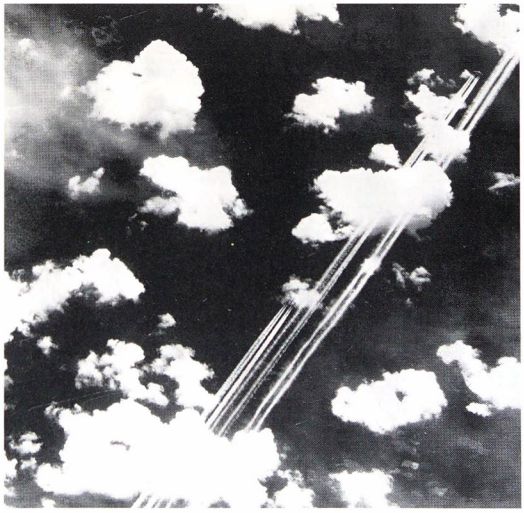
A year later McNamara approved yet another increase to 1,200 and then finally 1,800 B-52 sorties per month. On 1 November 1968, President Johnson called a halt to Rolling Thunder bombing against North Vietnam. Target emphasis for the B-52s changed to Commando Hunt operations in an effort to stem the tide of men, equipment and fuel being infiltrated into South Vietnam via a supply network in Laos. Eight months after the election of President Nixon, Secretary of Defense Melvin Laird cut the B-52 sortie rate to 1,400 per month. Two years later, the monthly rate was further reduced to 1,000 sorties and many aircraft and crews were returned to the US.

In early 1972, however, an enemy build-up along the Laotian trail network indicated the prospects of an imminent offensive. Gen Creighton Abrams and Adm John McCain (CINCPAC) requested additional Arc Light sorties to forestall this rising threat. On 8 February the JCS authorized 1,200 monthly sorties and ordered 29 more B-52s to Guam. In a major invasion effort on 30 March 1972, the enemy hit South Vietnamese positions in Quang To, Kontum Pleiku and Binh Long Provinces. As a result, President Nixon ordered a resumption of the bombing of North Vietnam, a policy that had been in abeyance since 1 November 1968. As the situation worsened on all three fronts, B-52Gs were deployed for the first time. They brought the bomber force to 133 aircraft, which could fly as many as 2,250 sorties per month.

In an operation code named Linebacker, five B-52 strikes were launched, the first on 9 April against petroleum storage facilities and the railyard at Vinh. This was followed by a raid code named Freedom Dawn on 12 April that hit Bai Thuong airfield; four days later, Freedom Porch Bravo targeted petroleum, oil and lubricant facilities around Haiphong. Then, on 21 April, Freighter Captain launched strikes against Hamn Rong, the trans-shipment point and the Thanh warehouse area. Two days later, Frequent Winner re-visited the same target list as that hit on 21April. Linebacker marked the first time that B-52s had ventured into the heavily defended Hanoi-Haiphong area, and they came away unscathed.

SAC was requested to increase the number of SR-71 reconnaissance sorties to obtain imagery for bomb-damage assessment. On 8 May, as the war escalated, President Nixon ordered that routes into and out of North Vietnam harbours should be mined. The next day, in an operation code named Pocket Money, the JCS directed that drones and the SR-71 should photograph, on a daily basis, the ports of Haiphong, Hon Gai, Gam Pha, Dong Hoi, Quang Khe, Vinh and Thanh Hoa, to identify the enemy's shipping channels in readiness for US Navy aerial mining operations.

One week into the operation, the JCS designated the SR-71's HRR as an acceptable sensor for this purpose. This is the first occasion that the JCS had specifically directed that the HRR should cover a predetermined intelligence target and, by so doing, it signalled that the technology had officially come of age.



▼ This cell of three B-52s – in standard combat formation for the type – was photographed by an SR-71A's TROC as the cell crossed into North Vietnam some 50,000ft below the Habu. (USAF)

In June, the JCS required the SR-71 to photograph communication and logistics supply lines between North Vietnam ports and Chinese border areas. Throughout this time the SR-71 also used its sophisticated electromagnetic reconnaissance system to collect ELINT, as part of SAC's Combat Apple SIGINT collection operation in South-East Asia, which also used U-2 and RC-135 platforms. As the situation on the ground continued to deteriorate, additional B-52s were deployed to the region and by late June, 200 of the giant eight-engined bombers had been deployed to the region and were chalking up in excess of 3,100 sorties per month; they were having a decisive effect on the North's invasion.

On 21 April 1972, AFLC, in conjunction with the SR-71's Advanced Systems Program Office, began flight-testing the prototype Capability Reconnaissance Radar. It promised a significant increase in resolution over the Goodyear GA-531 installation then operational on the SR-71 fleet. The 12 evaluation flights conducted within the United States on the radar prototype were successfully completed by AFLC on 15 July 1972, and on 11 August Majs Bob Powell and Gary Coleman flew aircraft '975 to Kadena as part of the autumn Glowing Heat aircraft rotation; on board was the new radar, deployed for the first time to undertake its operational evaluation.

The first of these sorties was launched at 15:45 the very next day, the crew consisting of Bob Cunningham and his RSO George 'GT' Morgan. By November the new system had demonstrated capabilities that far exceeded those of the PIP radar.

Five more CAPRE units had been contracted by SAC and plans called for the final unit to be delivered by May 1973. However, the production radars experienced a 23 per cent failure rate during AFLC certification, many of the problems being attributed to the failure of a heat-resistant epoxy that caused the radar's antennas to malfunction. Before the production units could be deployed to Kadena, SAC insisted that ten successful flights from Beale must be accomplished. As a result, the first CAPRE production unit wasn't delivered to Beale until 5 June 1973, missing the June Glowing Heat aircraft rotation. SAC HQ therefore directed that the prototype CAPRE unit be retained at Kadena until the production models became available for operational use.

In late October 1972, President Nixon called a halt to bombing north of the 20th parallel in anticipation of a truce. As a hedge against peace talks becoming deadlocked or breaking up, he also ordered the JCS to plan new strikes against the North that would concentrate on the Hanoi-Haiphong areas. On 13 December 1972, the North Vietnamese delegation walked out of the Paris peace talks (throughout the long period of negotiations, North Vietnam had used the time to rebuild and strengthen its badly damaged positions). Two days later, Nixon ordered the execution of Linebacker II. Initially planned as a three-day B-52 maximum night effort, this major operation extended through 11 days of heavy bombing. The primary aim was to cut off the supply of equipment and supplies at their source and strangle the North's war effort.

On Day One (18 December), 121 B-52 sorties were flown. Two chaff corridors were sown by F-4s, but 100kt winds blew the protective curtain away before the B-52s arrived. Charcoal 1, a B-52G leading nine other Guam-based aircraft against the Yen Vien/Ai Mo warehouse area, was hit by two SA-2s and became the first B-52 lost to hostile action in the war. Two other bombers were shot down by some of the 200 SAMs launched that night.

On Day Two of the campaign, 93 B-52s hit targets that included the Radio Hanoi broadcasting station, Kinh No, Yen Vien, Bac Giang and Thai Nguyen. Another 200 SA-2s were fired, but no aircraft were lost; however, on the night of 20 December, six B-52s fell to SAMs. By Christmas Eve (Day Seven of the campaign), 11 B-52s had been shot down. After a 36-hour pause over Christmas, operations resumed. Using revised tactics, 113 aircraft battered ten different targets in seven 15-minute waves. Two more B-52s were knocked down

by SA-2s despite the fact that more than 100 fighter-bomber had suppressed SAM batteries in the Haiphong area.

An hour before midnight on 27 December 1972, Giant Scale mission GS663 got under way when SR-71 '975 lifted off Kadena's runway on what would prove to be the only Habu night sortie of the entire Vietnam War. Col Darrell Cobb and RSO Capt Reggie Blackwell's mission objective was to conduct a coordinated EMR/HRR sortie to determine if the North Vietnamese had acquired new equipment or employed updated procedures for the SA-2s that were responsible for generating such high B-52 losses. To achieve this, their arrival over the Haiphong/Hanoi areas was timed at precisely the same moment that 60 B-52s were to begin dropping their bombs on the railyards at Lang Dang, Duc Noi and Trung Quant, the Van Dien supply centre and three missile sites. With the North's defensive radar systems running at full stretch to cope with the raid, intelligence planners reasoned that this would be an ideal time for such a sortie. In addition, the SR-71, with its unmatched ECM suite, would provide additional electronic support for the bombers.

As they arrived over the collection area on schedule, Cobb and Blackwell observed numerous SA-2 firings. During the fleeting moments when they were crossing the immediate target area, they were able to radiate a blinding ECM blanket. During the course of the raid, only one Guam-based B-52 was lost. Darrell and Reggie landed back at Kadena at 0239 hours. The next day they learned that their mission had produced a wealth of intelligence data.

The two 60-bomber raids launched on the final two nights of Linebacker II saw all B-52s arrive back at their bases safely. Following the action on the night of 29/30 December, the North Vietnamese government expressed a willingness to return to the negotiating table. The B-52s had flown a total of 729 sorties during the 11 days of Linebacker II operations (340 from U-Tapao and 389 from Guam). Thirty-four separate target areas had been hit as the B-52s dropped about 15,000 tons of bombs.

The North Vietnamese had fired hundreds of SA-2s, destroying 15 of the bombers (nine B-52Ds and six B-52Gs), and damaging nine others. The stunning onslaught that the North had received from Linebacker II drove the North Vietnamese negotiators to the Paris peace talks to carry out deceptive negotiations in order to recover from what had been 'war-ending' destruction of their supplies and munitions.

A record of Linebacker's enormous level of destruction had been faithfully recorded by the Habus. The B-52s had clearly won the war at that point, but their victory was given away at the Paris peace conference. The JCS directed that CINCPAC temporarily suspend all offensive operations against North Vietnam with effect from 15:00Z on 15 January 1973. Reconnaissance operations were restricted to satellites and SR-71 missions. The conflict in Vietnam ended for the United States when the Paris Agreement came into effect at 23:59Z on 27 January 1973, which committed the withdrawal of US forces from South Vietnam. The agreement included: (1) the release of US prisoners of war within 60 days; (2) the formation of a Four Party Joint Military Mission; (3) the establishment of an International Commission of Control and Supervision; (4) the clearance of mines from North Vietnamese waters; and (5) free elections for all Vietnamese. In addition, the JCS prohibited 'all reconnaissance over North Vietnam and its claimed territorial waters.'

For the SR-71, the agreement signalled a large reduction in target tasking, followed by a reduction in the number of Kadena-based aircraft from four to three.

▼ Lt Col Darrell Cobb (right) and RSO Capt Reggie Blackwell completed the only operational night Habu mission of the entire Vietnam War, on 27/28 December 1972 in '975. They received Air Medals for the sortie. (USAF)

Following the ceasefire, OLKA continued to gather bomb damage assessment imagery of B-52 strikes in Cambodia in addition to the status of various North Vietnamese-occupied airfields; these included Tchepone in Laos, and Cam Lu and Kham Doc in South Vietnam. The Plaines De Jarres in Laos also received regular visits from the SR-71, in order to monitor the infiltration of men and materiel moving from North to South Vietnam.

On 17 February 1973, Carroll 'Bud' Gunther and Tom Allocca departed Kadena at 13:00hrs on mission GS-696, a four-hour operational sortie in aircraft '975. Of particular interest on this mission was the area around Khe Sanh airfield; the intelligence community was extremely pleased by the take once it had been processed. It revealed that adjacent to the airfield, AAA emplacements had been built and a new, unnumbered supply route and truck park was also discovered, together with a probable cave storage area and two operational SA-2 sites – the first to be discovered in this area since the late spring of 1972. Such a high level of activity led the analysts to conclude that the occupying Communists intended to make Khe Sanh a permanent control point for operations in the south of the country.

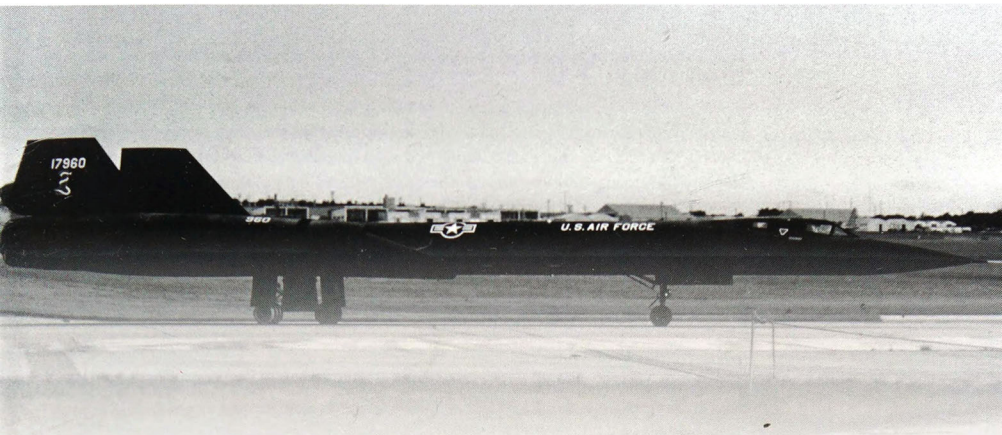
To comply with the terms of the Vietnam ceasefire prohibiting US reconnaissance aircraft overflight, the SRC devised a route for the SR-71 that involved six 45° bank-angle turns, enabling the aircraft's camera and SLAR systems to obtain imagery from well inside North Vietnam during peripheral missions. To ensure that the Communist North was adhering to the terms of the Paris accords, the JCS directed that two SR-71 sorties were to be conducted in April.

The first of these, GS-722 was flown by Majs Harold 'Buck' Adams and Bill Machorek in aircraft '971 on 19 April 1973. Owing to heavy cloud cover, the intelligence obtained during the sortie was almost entirely generated by the CAPRE high-resolution radar. It proved that the Viet Tri rail and road bridge, located 30 miles northwest of Hanoi, had been interdicted since imagery had been collected by Bob Cunningham and Jimmy Fagg in '975 during their 23 January mission. Photography collected during that earlier sortie had also caught 11 MiG-21s parked on the western alert apron at Phuc Yen airfield. However, analysis of the HRR imagery obtained on the 19 April sortie suggested that no aircraft were then on alert.

Photo interpreters noted that a similar situation had prevailed at Phuc Yen during Linebacker II, when the MiGs had been moved off the base's apron areas and into cave storage facilities; after the bombing halt and the signing of the peace accords, the MiGs were once again parked on the alert aprons. Intelligence specialists therefore concluded that the absence of interceptor aircraft at Phuc Yen on 19 April was consistent with an increase in alerted air defence posture.

Clearing skies enabled a conventional camera configuration to be carried on the second monitoring sortie; this would enable analysts to crosscheck the HRR imagery obtained five days earlier. Giant Scale flight GS-725 got under way on 24 April 1973 when Majs Pat Bledsoe and Reggie Blackwell left Kadena at 11:45 in aircraft '963. Additional targets covered by this 5.5-hour flight were the Ben Thuy trans-shipment point, and the petroleum products storage facilities at Vinh and Bai Thuong airfield. Yet again the SR-71 proved its worth. At Bai Thuong airfield, located 77 miles southwest of Hanoi, '963's cameras detected large amounts of materiel, equipment and vehicles, and evidence that bomb craters on the main runway and parallel taxiway had been repaired. Three coastal petroleum barges were noted in the vicinity of the Vinh bunkering pier and a moderate amount of activity was also recorded at the Ben Thuy trans-shipment point, located about four miles east of Vinh.

Parallel with the activity detailed above, within two weeks of the Vietnam ceasefire the Pacific Command ELINT Center requested SAC to provide increased electronic reconnaissance of various signal threats emanating from Laos. On 9 February 1973, SAC requested the SRC to schedule two SR-71 ELINT missions per week against Laotian objectives throughout the remainder of the year.



SS MAYAGUEZ INCIDENT

On Monday 12 May 1975, the US-registered freighter SS *Mayaguez* was stopped by a number of Khmer Rouge gunboats as it steamed in international waters some 60nm southwest of Cambodia, near the Paulo Wai Islands in the Gulf of Thailand. The merchant ship was boarded and the next day, under the control of its captors, moved to a point about two miles off the northeastern tip of Koh Tang Island.

The ship was initially located by two F-111s diverted from a routine training mission the day after its seizure. Thereafter, a round-the-clock surveillance plan was put into operation to monitor the *Mayaguez*'s movements. Just before dawn on 15 May, an assault was launched on two beaches at the northern tip of Koh Tang and a search made of the vessel in a bid to release its crewmembers. However, a small Thai fishing boat had been used to move the crew to the Cambodian mainland the day before, and the Marine boarding party found the freighter to be empty.

The assault force had gone ashore to encounter stiffer resistance than had been anticipated from a much larger and well-armed group of Khmer troops. To make matters worse, the 14-hour assault on Koh Tang cost the lives of 15 US Marines, with three missing in action (MIA) and 50 wounded, and four CH-53 helicopters shot down. Meanwhile, the same Thai fishing boat delivered the ship's crew unharmed to the destroyer USS *Holt*, in a gesture that seems to have been unconnected with the battle for their release.

The importance of the assault resulted in an SR-71 mission being scheduled to assess its aftermath. It was flown on 19 May by Capts Al Cirino and Bruce Liebman in aircraft '961 and their take was to prove extremely useful during subsequent debriefings.

Despite the war in South-East Asia having ended in August 1973, SR-71s from OLKA continued to conduct occasional overflights of Cambodia. Although never officially admitted, the large numbers of US troops listed as MIA continued to be a source of concern for the US government. This, together with occasional 'sightings' of MIAs and rumours of isolated prison compounds in inaccessible jungle areas, proved strong enough for various US intelligence agencies to request that flights be sanctioned.

One such mission was flown by BC Thomas and Jay Reid in '976. The five-hour 48-minute flight was conducted on 24 November 1980, seven years after the cessation of hostilities. No substantive evidence was produced by the aeroplane's sensors to back up any speculation.

▲ On 10 December 1977, Majs Rich Graham and RSO Don Emmons completed Giant Barnacle, a special coordinated mission with the US Navy in '960. (USAF)

GIANT SCALE II

In May 1978, Vietnam began a series of border skirmishes with Kampuchea and in late December these escalated into a full-scale invasion. Following the fall of Phnom Penh on 7 January 1979, the Vietnamese-backed rebel forces declared Pol Pot and the infamous Khmer Rouge overthrown and formed a government. However, fighting between the rival factions continued in the west of the country, creating in the process thousands of refuges who fled into neighbouring Thailand.

Concerned that an estimated army of 200,000 Vietnamese regulars in Kampuchea might turn their weapons on them, the Thai government requested reconnaissance coverage of the area from its long-standing ally, the United States. In total, five SR-71 sorties were flown in support of this request under the SAC code named Giant Scale II, the first by Tom Keck and Tim Shaw in aircraft '979 on 17 February 1980. This was followed by Rick Young and Russ Szcepanik, again in '979, on 3 May; Gil Bertelson and Frank Stampf completed a 6.2-hour sortie in '976 on 3 August; Bob Crowder and John Morgan chalked up their mission in '960 on 22 November; and BC Thomas and Jay Reid completed the series in '976 on 24 November.

Each round-robin sortie from Kadena covered approximately 6,500 miles and required three air refuellings, one over the Philippine Sea and the other two over the Gulf of Thailand. All five were PHOTINT missions with the aircraft configured with an OBC unit in the nose and TEOCs in the chine bays. Four of the five sorties secured standard black and white imagery of the target area, but the JCS directed that the cameras for the mission flown in '960 should be loaded with Kodak SO-131 camouflage detection film.

This film coloured healthy vegetation red and dead or dying vegetation various shades of grey and white. The result was used to gauge the probable yield of the rice crop, since Kampuchea had become a member of the United Nations in September 1980. After processing, the imagery was forwarded to the DIA where it helped plan the US contribution level to the food relief programme. The reconnaissance imagery collected during the other four sorties failed to reveal any large concentrations of Vietnamese forces or equipment along the Thai border and after sanitization it was passed, via the US embassy in Bangkok, to high-level officials in the Thai government.

GIANT COBRA AND GIANT EXPRESS

The Horn of Africa is an immensely important strategic location, guarding the Red Sea approach to the Suez Canal and overlooking the oil arteries of Saudi Arabia, Iraq, Oman, Kuwait, Djibouti and the United Arab Emirates as they fan out from the southern entrance to the Red Sea. In August 1977, a war broke out between communist-governed Ethiopia and its neighbour, Somalia. In November that same year, the Soviet Union began airlifting arms to Ethiopia and these were backed up by Cuban troops sent by Fidel Castro. By March 1978, it was estimated that approximately 11,000 Cuban troops were in country, and two Soviet generals were directing the ground war against Somalia.

The JCS directed that SAC should position a Kadena-based SR-71 to Diego Garcia, a small British-owned island in the Indian Ocean, and plan a round-robin PHOTINT reconnaissance mission over the area to monitor the extent of Soviet and Cuban presence. In response, the SRC prepared a track for such a sortie and the JCS directed that the flight should launch on 12 March 1978. However, the theatre situation changed dramatically early in the month, when Somalia suddenly withdrew its troops from Ethiopia and agreed to keep

them out, provided that all foreign troops also consented to leave the region. The mission was cancelled even before the SR-71 had been positioned to the island.

The event, however, proved to be a catalyst in preparing Diego Garcia to support SR-71 contingency operations in the Indian Ocean area. In just three weeks from mid-February, an SR-71 shelter at Beale had been dismantled, transported to and re-erected on Diego Garcia, as were a water demineralization plant, rations and a number of 376th Strategic Wing KC-135Qs carrying JP-7 fuel. The fragmentary order for contingency operations in the theatre was initially code named Giant Cobra.

As the region slipped into further political upheaval with the rise to power of Ayatollah Khomeini and his brand of Islamic fundamentalism in Iran, and Soviet involvement in Afghanistan, it was decided to further bolster facilities on Diego Garcia in the event that national intelligence users required more extensive coverage of the area. On 2 April 1979, the JCS directed SAC to create a permanent SR-71 fuel storage facility on Diego Garcia. Initially, two 50,000US gal polyurethane fuel storage bladders were deployed and filled by ten Kadena-based KC-135Qs in an operation code named Giant Ace.

On 1 May 1979, a follow-on fragmentary order code named Giant Express took cognisance of the deteriorating situation and included not only the Indian Ocean area but also Africa and South-West Asia as potential theatres of operation from Diego Garcia. Further developments on the island by the US Navy eventually freed up a 1.26 million US gal fuel tank for prospective SR-71 operations, which was filled with JP-7 delivered by ocean tanker.

During the summer of 1980, the JCS approved a plan to exercise the newly created SR-71 facilities; on 1 July Bob Crowder and Don Emmons completed the four-hour 24-minute flight in '962 to the island. The flight included three air refuellings, two from '135s operating from Kadena and a third from tankers that had been deployed a week earlier to Diego Garcia. The aircraft and crew returned to Kadena on 4 July, but despite validating the facilities and subsequent sorties being flown in the region, SR-71s never returned to the tropical island.

CHINA AND THE SOVIET UNION

The aftershocks of the Gary Powers incident ensured that A-12 or SR-71 overflights of the Soviet Union remained politically unacceptable. Some extremely useful intelligence had, however, been obtained of communist China by Chinese Nationalist pilots flying U-2s loaned by the CIA. The costs in pilots and machines had been high in that programme, however, with a number of aircraft shot down by SA-2s. The only peacetime aerial reconnaissance programme options open to the United States when it came to gathering intelligence data over these enormous countries were satellites and stand-off viewing. Det 1 performed the latter mission successfully against both countries.

Despite the fact that these stand-off flights were being conducted in international airspace, the Habu crews that flew them remained convinced that given the opportunity, Soviet fighters would attempt a shootdown and their pilots argue about the aircraft's position afterwards. There can be little doubting the acute irritation that such flights caused the Soviet leadership.

On 29 October 1979, Majs Rich Graham and Don Emmons were airborne from Kadena in '962 on just such a stand-off flight. Nearing Petropavlovsk (on the east coast of the Kamchatka peninsula) they observed two medium-altitude circular contrails ahead of them. As they continued, the two MiGs attempted a snap-up manoeuvre, but were unable to get close to the Habu. Rich and Don later observed four more contrails, belonging to MiGs whose pilots were waiting to attempt a similar intercept. Rich said to Don, 'Let's show them that we know they're there and that we don't care.' Rich dumped a small burst of fuel that

created a high, fast vapour trail. No attempt was made by the MiGs to intercept the 3,000ft-per-second target that passed high above them. Such potential intercept actions were typical of activity that greeted many stand-off flights during the Cold War.

There were few possible track variations for a stand-off sortie; crews could essentially fly up or down a coastline, or fly towards it and break away to the left or right. To keep the Soviet defence controllers guessing, Lt Col Tom Alison, at the time the Det 1 commander, thought up an innovative sortie with a difference.

On the morning of 27 March 1984, Majs Stormy Boudreaux and Ted Ross got airborne from Kadena in '964 and headed northeast towards Vladivostok. Back at Beale AFB, Lt Col Les Dyer and Maj Dan Greenwood launched in '973 and headed for deployment to Kadena via Vladivostok. In a masterpiece of co-ordination and choreography code named Busy Relay, the two aircraft streaked towards one another from opposite directions at a closure speed of Mach 6, crossing course just 3 miles apart.

Stormy and Ted then turned right to trace Les and Dan, who proceeded them south and then west across Korea just south of the demilitarized zone. As expected, the appearance of two SR-71s off Vladivostok triggered a series of atypical reactions from the region's numerous radar sites, and the ELINT collecting systems of both SR-71s and an RC-135 also sent to the area yielded a rich SIGINT harvest.

ANOTHER LOST HABU

After more than 21 years of operating from Kadena and 17 years without a Habu at any location, '974 crashed near the Philippines on 21 April 1989. Lt Col Dan House and Maj Blair Bozek had departed Kadena and headed 'straight out' to speed and altitude without a top-off air refuelling, ready to perform a routine stand-off sortie off the coast of South-East Asia. After Dan levelled off at 75,000ft and Mach 3, the aircraft began yawing to the left. Blair asked Dan, 'Is that an unstart?' Dan replied, 'I don't know'. It did not appear to be a typical unstart and the inlet had not recycled. Dan continued to monitor his instruments and saw that the left engine's gauges were winding down. He told Blair that the left engine had quit. By then there was no RPM, no EGT or oil pressure and the pressure gauges for the A and L hydraulic systems indicated 'zero'. The left engine had seized and the SAS had also begun failing, adding considerably to their woes.

It had been a surprisingly gentle process, but the crew began planning for a diversionary landing while following up on their engine-out procedures. At that point, the right engine went through four unstarts, during which another of the flight control's SAS channels failed, leaving them with only one out of six. As the aircraft lost speed and altitude, it entered a series of lateral gyrations that threatened to it beyond the limits of its flight envelope. Dan described the incident:

> It felt like we were experiencing a series of falling-leaf manoeuvres. We were 'wrapping up' from one side to the other. I was ramming the stick through full-throw, back and forth, as quickly as I could, but the aeroplane was doing pretty much what it wanted. That got me quite excited because from Mach 3 to Mach 2.5 I felt that I had no control whatsoever. I was most concerned because I didn't understand its cause.
>
> Well, somehow or other we flew out of that wild series of gyrations and I decided to divert into Clark AFB in the Philippines. We continued to descend and slow to subsonic speed on one engine and completed all our obligatory radio calls. Just when things appeared to be getting better, they suddenly got worse. I told Blair, 'We've now

got a B hydro light,' which meant that our remaining hydraulic system was getting low on fluid. By then we were at 400kt and 15,000ft and the B system's pressure gauge started to fluctuate. Our situation was now really deteriorating. I quickly updated Blair on the potential failure of my flight controls and told him to 'hang on'.

We were just off the north coast of the main Philippine island of Luzon and we agreed to remain over water as we proceeded toward Clark because if we had to leave the aircraft, we didn't want it dropping on peoples' heads, and we didn't want classified material falling into the wrong hands. So we turned left into the dead engine, as that was the easiest way to turn, and flew along the coast looking for anywhere suitable to land. Blair thought he saw a field and asked me if I could still control where I was going. At that point, I was holding full left rudder and saw that the B hydro had 'zeroed'. As I replied to Blair, 'No, I can't any longer,' poor old '974 began wrapping up to the right very rapidly. I shouted, 'Bail out! Bail out! Bail out!' and pulled my ejection seat's D-ring.

I remember hitting the top [of the ejection seat rail] and the sensation of light coming into the cockpit as the canopy blew off. The next thing I recall was the reassuring tug as my 'chute opened. We'd gone out at about 400kt and 10,000ft. The elapsed time from the initial yaw to ejection was about 16 minutes. I checked the 'chute, which was fine, and then started looking for Blair, whom I could not immediately spot. It seems he'd gone out after me because he wasn't in the correct sitting position for a safe bailout. Therefore, he was ahead and above me. When I finally located him, I started looking for '974, which was under me, falling straight down in planform. It happened to be upside-down and was not pitching or tumbling. As she hit the water, there was a splash and a brief fireball. Then all was gone.

I readied myself for a feet-wet landing. My descent rate under that 35ft-wide canopy was very slow, so I had plenty of time to look around. It was a sunny morning, there was no wind, the vegetation on the island was lush and green, and the calm blue ocean I was about to enter was flat, with no waves. I could see fishing boats turn toward me and by the time I'd cleared my 'chute, a Bonka boat had arrived next to my position in the water. A Bonka boat is a 20ft dugout canoe with outriggers on either side and powered by the noisiest internally-mounted two-stroke engine I have ever heard in my life.

Two Filipino fishermen offered to lift me into their boat, and since one of my life rules was to never give up a free ride when you're shark bait, I gladly accepted. They retrieved all my life-support gear and lifted the parachute aboard their little boat and then we went over to where Blair was waiting. He'd gotten into his liferaft and was just climbing into another Bonka boat that had raced toward him as he descended. He tried the survival radio but couldn't hear anything because the search and rescue forces were still too far away. We went to the scene of the aeroplane's impact where there were only a few pieces of debris and some fuel floating nearby.

We then asked the Filipino fishermen to take us ashore. They told us that the area opposite was controlled by the New People's Army (communist insurgents who occupied the island), so they took us instead to a town that was a two-hour ride to the east. After they handed us over to an officious policeman who was a member of the local militia, we tried to call Clark Air Base, but no one knew the phone number. Next, we asked to talk to the US consulate in Manila, but we had to wait our turn behind about 30 other people waiting to use the one phone. They eventually decided to take us to some local officials who could certainly help us. We'd taken our pressure suits off and were wearing the dark green nylon lining over our long underwear.

We entered a large building carrying our survival gear and parachutes and were introduced to the mayor and town council. They were very concerned for our well being and asked if we needed to see a doctor. When we told them that it wasn't necessary, they invited us to have lunch with them. We had a wonderful meal of rice, pork, vegetables and pickled squid, plus the best ice-cold bottles of Coca-Cola we'd had in our lives. The mayor then insisted that we take coffee with him at his home.

While our survival radios were sending out their radiant signals, 'come save us, come save us,' we were enjoying coffee on the mayor's lawn! We had asked if there was a radio transmitter anywhere. Eventually they agreed to take us to one. As we were en route, a Lockheed P-3 Orion flew overhead. We stopped the truck and made contact, but our radio reception was not very good. On reaching the short-wave radio, we identified ourselves to the Orion crew and were told that a helicopter was on its way to pick us up. We drove back to the mayor's house and Blair positioned himself in a dried-up rice field to greet the helicopter's crew. Meanwhile, I went back to the mayor's house for a final cup of coffee and to thank him and his countrymen for their wonderful hospitality. I also picked up our mission gear, which we'd left on the patio.

The HH-53 Super Jolly Green Giant took us back to Clark Air Force Base. The crew was superb and wanted to take us to the 'O' club for a few 'coolers', but post-accident rules dictated that they had to hand us over to the medics for a physical examination. After this rather wild five-hour adventure, we were strapped to a stretcher by four medical corpsmen who put us in an ambulance. I had not been so helpless since '974 underwent the falling-leaf gyrations. Once we were in the ambulance, the doors were closed and the driver backed up no more than a hundred feet before the doors were flung open once again and they carried us into the hospital. Other than our bad attitudes for their seemingly stupid procedures, they found nothing wrong with us and after 24 hours of 'observation' they released us.

Side-scanning sonar imaging of the crash site took place on 29 and 30 April, and it was not long before the debris field of '974 was located. The 280ft-long salvage vessel USS *Beaufort* was dispatched to lift the wreckage with its 10- and 15-ton cranes, fitted on the bow and stern, respectively, and to find the sensors and defensive systems. Due to the proximity of the communist New Peoples' Army, a number of Navy SEALs were on board to provide protection to the divers and crew.

One morning during the search an order for General Quarters was sounded at 0400 hours. Crewmen rushed to their action stations in readiness for an immediate confrontation. They saw a large number of small vessels (which had been detected on the Beaufort's radar) making for the ship. Tension mounted until it was discovered that the would-be attackers were fishing boats that had come towards the bright lights of the naval vessel because a very large school of fish had congregated around it.

When '974 impacted the water inverted both engines, the main undercarriage and the aircraft's sensors smashed through its upper surfaces. They were scattered on the ocean floor at varying distances away from the main wreckage. On the evening of 1 May, wire hawsers were attached to one of the J58 engines. The late evening movements dislodged the TEB tank and caused a small leak, which released tiny amounts of the chemical throughout the night. As the volatile chemical bubbled to the surface, it mixed with ambient air and exploded in small green puffs. The 'magic' of the 'Yankee' engineers caused quite a stir among the native fishermen who saw the eerie 'TEB-bubble show'.

The next day both engines were lifted and brought aboard the Beaufort's fantail, and two days later many of the sensors were also recovered. When the ship's crew attempted to lift the

main section of the aircraft, the crane operator found that the large delta-shaped wing planform greatly exceeded the lifting capacity of his crane, and the wreckage refused to budge an inch. A yard derrick was sent from Subic Bay and the forward fuselage section was recovered on 7 May, while the main structure was lifted aboard the *Beaufort*'s fantail the following day. The black wreckage was a sad end for a once-proud aeroplane, despite Dan's skillful and valiant efforts to save it.

CONFRONTATION NORTH KOREA

Three reconnaissance sorties were flown over North Korea by Oxcart pilots in 1968, the effort passing to SAC as a long-term role in early 1968 when the 9th SRW's OL-8 (OLRK) inherited the CIA's facilities at Kadena. The principal objectives of these Western Pacific or WESTPAC missions were indication and warning targets, with most of the operational objectives achieved from international airspace off the North Korean coast or over the demilitarized zone (DMZ). Such missions were launched to satisfy the requirements specified primarily by CINCPAC on behalf of the intelligence users who operated under his jurisdiction, the most important of whom were COMUSK, Commander in Chief, Pacific Fleet (CINCPACFLT) and the Intelligence Center Pacific (ICPAC).

The justification for designating this region as a principal area of operations was based upon the fact that by 1977, North Korea had an army of 450,000 men (by mid-1978, the DIA and CIA believed that this number had increased to between 550,000 and 600,000), which made it the fifth largest army in the world. In addition, the country's unpredictable dictator Kim Il Sung was committed to reunification of the peninsula under his form of communism.

Admiral Maurice Weisner, CINCPAC, believed that given the sophistication of North Korea's weaponry and the level of training undertaken by its troops, the North could order an attack across the DMZ at virtually any time. He therefore requested the JCS, which in turn directed SAC, to increase the number of monthly SR-71 monitoring sorties to the area from eight to 12. The SRC then scheduled the SR-71 to be configured with cameras on two of the sorties and to gather RADINT, using its HRR, and ELINT on the remaining ten. The PHOTINT provided a reference base for intelligence specialists to use when interpreting the HRR imagery.

North Korea's propensity to relocate or reinforce its military units and installations along the DMZ at night prompted further requests from US theatre commanders that the majority of these SR-71 'indications and warning' sorties be conducted at night. This was communicated by the JCS to the SRC, and at 21.05hrs on 19 September 1977, Jack Veth and his RSO Bill Keller left Kadena in '960, returning 4.1 hours later having completed the first night monitoring sortie of North Korea.

Four additional RADINT/ELINT night sorties of North Korea were completed before the end of the year (27 September, by Kinego and Elliott in '967; 16 and 25 November by Alison and Vida in '967 and '960; 13 December by Carpenter and Murphy, again in '960). The crews that flew these important missions were less than impressed by their nocturnal forays, noting that the aircraft's cockpit lighting was uneven, causing reflections that made monitoring instrumentation extremely difficult and potentially dangerous, especially during the descent phase to rendezvous with a tanker. This situation could be further complicated by a lack of horizon; such conditions could well trigger vertigo and pilot disorientation, leading to the loss of an aircraft.

Therefore, after the first two sorties flown in September, the mission profile was amended and the number of air refuellings reduced from two to one. The decision reduced the number

▲ During an operational mission over the Korean DMZ on 26 August 1981, '976 was fired upon by an SA-2. (Via Tony Landis)

of passes made through the sensitive area from two to one, which in turn also reduced mission flight time from just under 4.5 hours to approximately 2.5. Finally, in a further move to alleviate the problem, thee missions were flown at Mach 2.8, reducing turn radius and enabling bank angles to be restricted to a maximum of 35°.

The situation was finally rectified in 1982, when the cockpit lighting was improved and Peripheral Vision Horizon Display (PVHD) units were fitted in the SR-71 fleet. These projected a thin red line of light across the aircraft's instrument panel to produce an artificial horizon that responded to changes in pitch and roll, thereby duplicating the behaviour of a natural horizon.

In April 1981, SR-71 flights began collecting ELINT cuts and other raw data on a suspected SA-2 site that was under construction on the island of Choc Tarrie in an estuary near the western end of Korea's DMZ. In July, Maj Maury Rosenberg and his RSO Capt Ed McKim arrived at Kadena to begin their first operational TDY together as a qualified SR-71 crew (although this was Maury's second SR-71 tour). Both Maury and Ed were very experienced aviators. Prior to being selected for Senior Crown, Maury had completed combat tours in Vietnam as an F-4 pilot and Ed as a B-52 Radar Navigator, so both had been shot at and flown in 'harm's way'. By late August, they'd flown a few sorties through the DMZ and had received radar signals from the suspected missile site.

The SAM site was capable of spoofing the aircraft's DEF systems by simulating tracking, locking on and firing a missile. It could even send spoof guidance command signals to the missile. For this to happen there had to be a site on the ground but whether is was operational and had missiles was difficult to determine.

The SR-71's DEF systems were extremely sophisticated and had the ability to intercept the guidance signal and identify if the missile responded, which would mean it was definitely airborne and on its way. Once the DEF system confirmed missile guidance responses, the RSO would initiate the its full jamming capability.

On 25 August, Maj Nevin Cunningham and Gene 'Geno' Quist climbed into '967 for a two-loop sortie of the 'Z' area. Before each flight, Det 1's intelligence officer kept crews

appraised of the SA-2 site's most recent developments, as it was becoming increasingly apparent that the North Koreans were about to embark upon another 'adventure in belligerence'.

Although it was clear over the target area, the primary sensor for this four-hour sortie was the SLAR. During their fourth and final pass over the DMZ, the crew found themselves carrying excess fuel, so Nevin flicked his fuel dump switch in quick Morse code bursts that spelled out a four-letter expletive for the benefit of the North Korean ground trackers attempting to follow the SR-71 visually. Their humour was probably lost on the enemy, but it brought lots of laughs back at the Habu bar at Kadena.

The next morning, Maury and Ed were briefed a three-pass mission along the DMZ. This was to be the last flight of their tour before heading back to Beale in a tanker. Once again they were told about the suspected SA-2 site, at which Maury asked the intelligence officer: 'Who determines when a suspected site becomes a confirmed site?' He was told that the Defense Intelligence Agency made the final call on such issues, and asked, 'So what do we have to do before we can confirm it? See a missile?' The intelligence officer replied, 'Well, that would surely help'.

Maury and Ed launched in '976 on their 'Z' sortie and headed for the first air refuelling. After tanking they flew through the Straits of Formosa and made their first pass from west to east along Korea's DMZ. They then turned south and flew down the east coast of South Korea toward their second refuelling. Thereafter they reversed course and after reaching operational altitude off the west coast of South Korea, they repeated their west to east run across the DMZ. Coasting out to the east, Maury made a right and left 90-270° turn, which put '976 on an east to west pass.

Approaching the western side of Korea at Mach 3 and 77,000ft, Ed remarked that he was getting some DEF system activity, and that 'everything was turned on'. In the next breath he exclaimed, 'Wow! It looks like we've had a launch'. Maury accelerated to Mach 3.2 and told Ed, 'I see a contrail! I'll be damned, it's coming right at us'. Maury made a slight turn to the left away from the rising contrail, which took them further into South Korean airspace, and watched as the SA-2 missed by a good 2 miles, exploding behind and to the right at about 80,000ft.

Always mindful of the sensitivity of such sorties, the US authorities monitored these SR-71 flights very closely. Almost as soon as '976 came off track, Ed received an encoded HF message from Sky King concerning the track deviation. There was no mention of the hostile missile firing. The RSO responded with the appropriate messages but found there was not a specific coded message that could be sent alluding to the missile incident. As a result of this mission, a coded message format was later added should a crew find themselves in similar circumstances. It was not until the Habu crew arrived back on 'the Rock' that they could inform the staff they had been shot at.

The incident was of such importance that a coded message was dispatched to all interested agencies, including the National Security Council. Secretary of Defense Casper Weinberger informed the president of the firing, and a series of high-level briefings followed. Deputy Secretary of Defense Charles Carlucci recalled that President Reagan was 'furious' over the incident. Meanwhile, Dean Fischer, a spokesman for the State Department, said, 'The Reagan Administration roundly denounces this act of lawlessness,' adding that the attack violated 'accepted norms of international behaviour'. Despite faultless photographic evidence of the North Korean missile firing at an aircraft over South Korea, the North Korean government denied the missile charge. While the diplomatic rhetoric continued, Det 1 was told to move the reconnaissance track flown by the SR-71 even further to the south. Six days later, Nev Cunningham and Geno Quist flew a typical four-hour, two-loop sortie along the 'Z' in '976, with little reaction.

▶ Capts Maury Rossenberg (left) and his RSO Ed McKim were fired at by an SA-2 on the final mission of their first operational tour together. (USAF)

Majors BC Thomas and Jay Reid arrived at Kadena during the period of high-level interest in the Det's Korean activity. On 26 September, Deputy SECDEF Frank Carlucci visited the island and was briefed on their operations and shown an SR-71 for the first time. Carlucci met with the Habu crewmembers and explained that the DMZ route package had been moved further to the south for the moment, but that they would return to their former DMZ routes after 'certain preparations' were made. He did not explain what those preparations were, but seemed angry about the attempted shootdown. He added that the US government viewed such hostile actions with serious concern, and emphasized that the president would not stand for a repeat.

On Friday, 2 October, BC and Jay flew '967 on a sortie off the eastern coast of China, North Korea and the USSR. They reported an unusual massing of ships off the coast of North Korea. The next day, Lt Gen Mathis (Assistant Vice Chief of Staff) held a special briefing for the Det's crewmembers in which he told of four special category missions that were to be flown on routes following the same triple-pass track that Maury had flown when he was shot at on 26 August.

He emphasized that the timing would be extremely important, and that the Habu was to be over the earlier mission's firing point within 30 seconds of the mission's preplanned timing. Timing control triangles would be built into the flight track after the second air refuelling to ensure that the precise constraints were met. One of the pilots asked why timing was so important. General Mathis explained that Wild Weasel anti-radar strike aircraft would be poised to hit any North Korean SAM site within 60 seconds of a launch against the SR-71. The time constraint would ensure that the strike aircraft were headed in the right direction at the moment a missile was launched. President Reagan had personally approved the plan.

Operational sorties to the 'Z' continued to be flown along the amended route until Monday, 26 October 1981. Following extensive mission planning and detailed briefings, BC Thomas and Jay Reid took off from Kadena exactly on time in '975. All four of these high-priority missions were ground-spared as insurance against an abort of the primary aircraft. BC recalled:

> We had to employ the timing triangles to lose a few minutes of 'pad'; we also delayed with the tanker all the way to the end of the second air refuelling for the same reason. We flew over the critical point within ten seconds of the designated time, feeling very proud of ourselves.
>
> We all felt that it this mission, which had such importance attached to it, and all of the preparation that had gone into it, to be the pinnacle of our professional efforts. Even though there was no firing, I experienced the greatest sense of well being, knowing we did the whole operation exactly as planned. I must admit that I'd hoped that the North Koreans would fire at us. Their missile capability never bothered us, and I believe that it is fair for me to say that by immediately smashing their launch facility, our national resolve would have been most graphically demonstrated.

For whatever reason, the North Koreans chose not to launch a missile at this or any other trawling mission, and BC and all who followed him, recovered safely after each four-hour flight.

The profile devised to monitor North Korea meant that crews new to the Senior Crown programme would initially cut their operational teeth in this theatre rather than in the more constrained airspace over Europe. Major Douglas 'Curt' Osterheld, an RSO, eloquently describe an incident that occurred during his first operational tour as a captain, in aircraft '976 on 23 January 1984:

> There were many rewards for being a crewmember in the SR-71. After the long first year of initial training, one of the biggest rewards was to embark on your first operational tour to Kadena Air Base, Okinawa, Japan. This was where you would finally win your Habu patch, as well as experience the many hallowed traditions of the island paradise.
>
> I was privileged to fly with Joe Matthews as my front seater and accomplice in numerous adventures. Joe was a superb pilot. We'd served together before in RF-4C Phantoms, an aircraft which is deserving of its own book full of flyer's tales. We'd had our share of emergencies during our training at Beale, but that really is to be expected. The simulator and student sorties were intended to build not just your knowledge of the jet, but confidence that you could handle whatever the airplane had in store for you. It's only fair to reiterate that since each SR-71 was handcrafted, each aircraft had something different up its sleeve for the unwary.
>
> Our first couple of sorties from Kadena were the perfunctory island orientation ride, then a 'single loop' mission just south of the Korean demilitarized zone. The latter qualified us for the Habu patch, so now we could savour the accomplishment of being fully operational SR-71 crewmembers.
>
> The 'savouring' dissipated slightly during our next operational mission, since we were challenged with a series of malfunctions that left us, for a time, completely mystified. The mission objectives were to perform electronic intelligence gathering over the Yellow Sea, then make a standard photo run over the Korean DMZ. Everything was pretty routine through the first air-to-air refuelling. Then, during the climb to operating speed and altitude, we began to encounter some moderate clear air turbulence. From the cockpit, this feels much like sitting on the end of a diving board as it oscillates up and down. At approximately 45,000ft and Mach 1.4, there was a severe jolt that knocked our helmets against the canopy. After that, the air seemed to smooth out and we continued the climb/acceleration.
>
> At Mach 3 and 79,000ft, we seemed to be well on our way when, for seemingly no reason, the autopilot disengaged. Our centre of gravity was not where it was supposed to be and fuel readings were erratic. Joe was fighting with the pitch trim and the autopilot would kick off just as soon as it was engaged. I was using the manual circular computer to 'spin' the CG over and over again, not believing the calculations.
>
> Now we were 4,000lb down on the fuel curve, or our planned amount of fuel for a specific point in the mission. Then 5,000. Then 6,000. Joe was using the small periscope to scan behind the aircraft for fuel leaks, but with its very limited field-of-view could see nothing abnormal. Again the autopilot kicked off. And now the nitrogen that served as our inerting atmosphere for the fuel tanks was depleting rapidly.
>
> Our options became very limited. With our remaining fuel, we couldn't continue with the mission and had to abort back to Kadena; truly a disappointing choice to

▲ On 26 June 1982, Majs Burnie Smith and his RSO Denny Whalen were preparing to take 61-7980 on an operational mission to monitor North Korea. Also on the Kadena run-up area were Majs Lee Shelton and Russ Szczepanik in 61-7967, as they conducted checks prior to a functional check flight. (USAF via Tony Landis)

make, since you are admitting failure. I made the required abort calls over the HF radio, telling the whole world we were heading home a lot sooner than planned.

The descent was spiced up with a couple of unstarts, but finally we were subsonic and only 80 miles away from Kadena. The mysterious fuel loss had stabilized and it seemed that now we could make a 'normal' recovery. There were a few brief moments for Joe and I to discuss 'what the hell was all that?' and other topics before talking with approach control. Both of us were wondering what we had done wrong … and what would be the detachment commander's reaction.

Joe made a great landing, which was followed quickly by an expletive over the intercom and news that the drag 'chute had not deployed. Some judicious use of the SR-71's powerful brakes got us stopped and we didn't have to use the emergency barrier. The barrier was a large diameter cable that pops up from the runway and catches the two main gear struts. I imagine the effect on the landing gear doors would have been very ugly.

Taxiing in, we ran the appropriate checklists and wondered 'what next?' As we pulled into the hangar, a number of the maintenance folks were pointing, wide-eyed, to the back of the aircraft.

After shutting down the engines, we had a large contingent of folks swarming over the airplane. Joe and I climbed out, took off the Lockheed ejection seat 'spurs' from our boots and put on protective boot covers. On the right wing, near the fuselage, was a jagged 10in. gash that looked like it had been made with a can opener. The drag 'chute that hadn't deployed on landing was missing altogether, as was the right drag 'chute compartment door from the top of the fuselage.

So we began to piece the mystery together. That jolt of clear air turbulence we felt at 45,000ft popped the right drag 'chute compartment door open and, once it was in the slipstream, it punctured the right wing and fuel tank 6 as it departed the aircraft. The drag 'chute was then sucked from its shallow tub along the top of the fuselage.

The genius of Kelly Johnson's engineering was evident here. The large drag 'chute was connected to the aircraft by a ball-and-jaws type joint. The jaws only closed around the ball when the pilot pulled the drag 'chute handle. Therefore, when the drag chute compartment door opened accidentally, the drag chute, still in a bundle

and not attached to the jet, could fall away free from the aircraft. One can imagine the aerodynamic loads placed on the aircraft, even for a brief time, if the chute deployed at supersonic speeds, connected firmly to the middle of the aircraft!

The gash in the wing/fuel tank explained the rest. Approximately 6,000lb vented through this hole, along with the nitrogen. This upset the delicate balance of the CG and caused erratic readings as the fuel transfer system attempted to fix the imbalance. This would cause transients in the pitch trim, which in turn would automatically disengage the autopilot. All very logical when you're standing on the ground.

This whole experience did have an upside. The instructors in the simulator now had a baffling new scenario with which to humiliate their students. Joe and I received little pink bunnies from our senior crew, to provide us with four 'lucky rabbit's feet' so something like this wouldn't happen again. We were beginning to feel like experienced Habus, even if it was just our first tour!

THE US EMBASSY HOSTAGE CRISES

In the face of a resurgence in Islamic fundamentalism, the pro-US shah of Iran was driven into exile on 16 January 1979. Iranian anti-US feelings grew progressively worse and when in October the exiled Shah was operated on in a New York hospital and diagnosed as suffering from cancer, Ayatollah Khalkhali urged Muslims to 'drag him out of his hospital bed and dismember him.' Worse was to follow on 4 November 1979 when the cleric's fanatical followers stormed the US embassy in Tehran, brushed aside Marine guards and occupied the building, taking almost 100 embassy staff and Marines hostage.

Over the next few weeks, non-US citizens were released and on 25 April 1980, in an operation code named *Eagle Claw*, mounted by America's crack Delta Force, an attempt was made to free the remaining 53 diplomatic hostages. Alas, the audacious raid went catastrophically wrong and eight would-be rescuers were killed in the desert, 200 miles southeast of their objective. For President Carter it was an international humiliation.

The collection of intelligence concerning the hostages was code named Snowbird, and this continued, as did military planning for another possible rescue attempt code named Double Star. But the only substantial intelligence assets available to the US after the aborted April rescue attempt were satellites. However, various options for collecting further intelligence were contemplated, including leaflet dropping, although it's not apparent what such an activity would hope to achieve.

On 26 June 1980, a feasibility study and cost estimate schedule was requested from Lockheed ADP to provide an SR-71 with such a leaflet capability. This was provided on 9 July, wherein it was envisaged that the system would be designed for internal installation in the existing TROC camera bay and be capable of dispensing 10,000 leaflets. It would be activated by air-charged initiators and powered by 1,000lb force actuators. Four systems, it noted, would be built, two flight-tested and two made available for operational use at a cost of $2.2 million. But nothing ever came of the idea.

Another plan involved US use of certain airfields near Tehran, from where a second rescue attempt could be launched. However, when it was learned that the Iranians might be attempting to block the runways of these airfields, the JCS requested that action be initiated to investigate the feasibility of an SR-71 overflying, using its HRR to define such obstructions. In response, an SR-71 mission was flown over Condron Army Airfield, White Sands, New Mexico on the night of 27 June when its runway was clear. A second sortie was flown over the

same airfield on the night of 30 June, after a combination of vehicles, steel drums, tyres, rocks, wire cable, logs and dirt piles were heaped along the runway's edge.

A qualified photo interpreter then completed an analysis of the SR-71's HRR imagery to ascertain what level of obstruction could be detected. In a memo for the record, classified Top Secret and dated 9 July 1980, it was decided that the CAPRE system was 'capable of detection of runway obstructions expected to be of concern for project Double Star.'

On 3 November 1980, Maj Gen James B. Vaught of the JCS submitted a top secret memo to the Joint Reconnaissance Centre, the subject: *SR-71 Mission Request*. It set out the following:

1. Request consideration be given to conducting several SR-71 surveillance missions of the Persian Gulf during the next 3–6 weeks.
2. Purpose of mission is to determine locations of major oil-rig concentrations and typical flow pattern of Gulf shipping to assist in selection of low-level air penetration routes.
3. Recognize that missions could raise Soviet/Iran/ME speculation; however, given irregular scheduling, direct association with any US military planning will probably be low. On the other hand, periodic SR-71 missions would provide 'reason' for increased tanker support in the area prior to the execution of any US military contingency action.

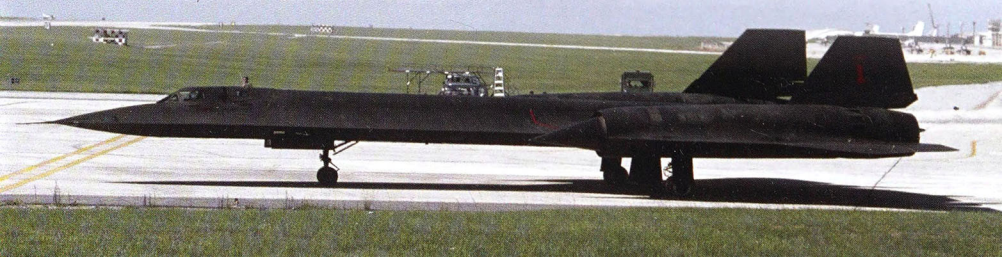
Despite the request, immediate action wasn't forthcoming and Det 1 was not tasked to perform these sorties – operations into the area would have to wait for another seven years. With the request on the backburner, diplomatic efforts intensified and finally came to fruition on 21 January 1981, when the remaining 52 hostages were released after a mammoth 444 days in captivity.

THE IRAN-IRAQ WAR

On 24 September 1980, a simmering border war between Iraq and Iran flared into full-scale hostilities when Iraqi troops and tanks crashed across the border. Their dawn attack set the world's largest oil refinery, and many of Abadan's oil storage tanks ablaze. The Iraqis quickly seized the port of Khorramshahr, and advanced 10 miles into Iranian territory. Despite initial successes by the Iraqi army, the conflict turned into a stalemate with both sides digging in and fighting a long and bloody trench war, not too dissimilar to the battles fought in Europe some 65 years earlier.

Both the USSR and the US made it clear that they would remain 'strictly neutral'. However, the US intelligence community fully understood how easy it would be for Iran to exploit the 'oil pressure point.'

▼ Majors Duane Noll and Tom Veltri hold short of the main runway before taxiing for take-off during an operational sortie in '968 on 10 September 1986. (US Air Force)



On 24 May 1984, two Iranian aircraft attacked an oil tanker off the Saudi Arabian coast. As East-West counter-charges continued over the next few years, Iraq's jets attacked the key Iranian oil terminals on Kharg Island and the Iranians attacked oil-laden supertankers bound for the West from Kuwait, Saudi Arabia and Bahrain. To offer greater protection to these unarmed vessels, the US government planned to reflag such vessels as American ships and escort them through the choke point at the Straits of Hormuz.

On 18 May 1987, two Iraqi Mirages F1s, each carrying an AM.39 Exocet anti-ship missile, locked onto a surface target in the waters north of Bahrain. They fired their sea-skimming missiles 12 miles from the target; the warhead on one of the weapons failed to explode. The other missile, however, worked with devastating effect, hitting the frigate USS *Stark*, killing 28 sailors and leaving the sleek warship disabled and burning. President Reagan immediately demanded an Iraqi explanation for the attack, which a Baghdad spokesman said was due to the pilots identifying the frigate as Iranian.

As the situation, particularly in the Gulf itself, continued to escalate, on 22 July 1987 Majs Mike Smith and Doug Soifer flew the first of four very long non-stop reconnaissance missions from Kadena into the region. Majors Ed Yeilding and Curt Osterheld backed them up as spare crew in '967. As the primary crew stepped from the PSD van towards '975, Col Tom Alison and Lt Col Tom Henichek (the Det commander and ops officer) informed them that '975's ANS had not checked out properly and they would have to take '967 instead. Ed and Curt would follow in '975 after its ANS problem was resolved.

The 11-hour sortie would involve two refuellings on the outbound leg and three on the return. As Mike and Doug approached their second aerial rendezvous, Doug called Ed and Curt, who were two hours behind in '957, and told them that everything was progressing well and their services would not be required that day. The most distant second and third tankings were to be carried out with three KC-10s before and after '967 had flown over the 'cuckoo's nest'. The KC-10s were able to extend their range by buddy refuelling each other. As a result of this, Mike was able to take on distant pre- and post-target split onloads from the two tankers during each AR.

The cloud cover had been almost continually undercast since they left Kadena, and since '967 was equipped with Technical Objective Cameras and an Optical Bar Panoramic Camera, it looked as if the mission could prove to be a very expensive failure. After much 'gas guzzling', they headed out high and hot to boom the Gulf region; suddenly the undercast disappeared and conditions were perfect for their high-resolution cameras to do some of their finest work.

Their fifth and final AR was completed ten hours after take-off. That night refuelling was complicated by the failure of one of the KC-10's boom lights, which made proper formation flying (in the close-in contact position) very difficult. Despite that added strain to an already tiring flight (at the near limit of an SR-71's and an aircrew's flight duration), Mike landed an almost zero write-up Habu back at Kadena after a flight lasting 11 hours and 12 minutes.

On 9 August, Majs Terry Pappas and John Manzi left Kadena in '975 and headed out for the first of several aerial refuellings. After clearing the first tanker, they climbed and accelerated towards South-East Asia and then on south of India towards a second refuelling and their

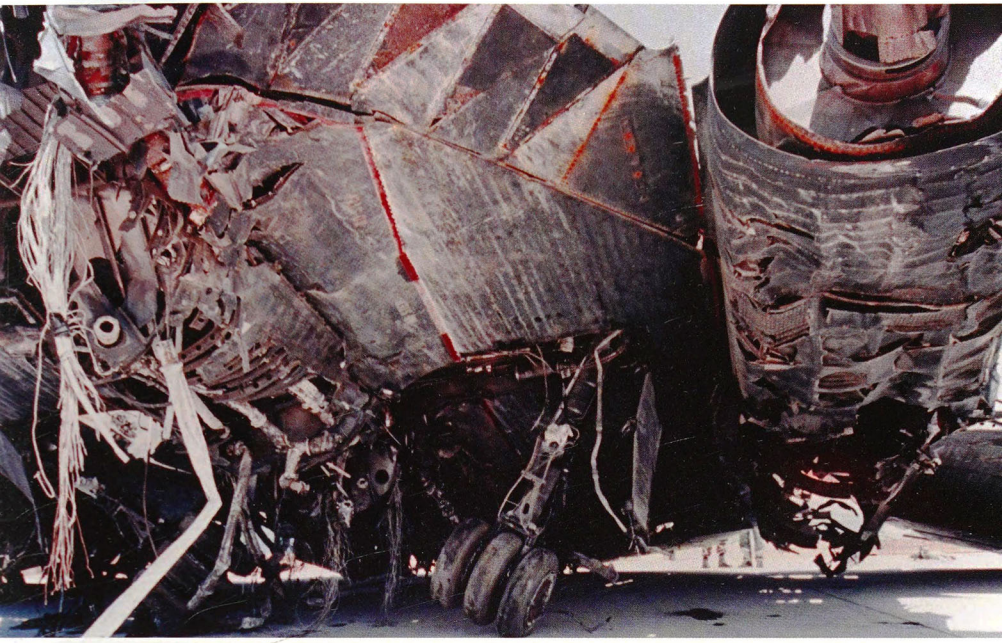
◀ Major Larry Brown and RSO Maj Keith Carter ferried '979 into Kadena on 3 July 1988, having completed an operational mission to monitor the Soviet fleet en route. The aircraft stayed for a relatively short time before being ferried back to Beale on 12 August by Lt Col Rod Dyckman and RSO Lt Col John Manzi. (Toshiki Kudo via Robbie Shaw)

▲ Majors Dan House and RSO Blair Bozek were attempting to divert into the Philippines before being forced to eject from 974 on 21 April 1989. (Lockheed Martin)

distant target area. Five hours after take-off they neared the collection area in the Persian Gulf. Everything worked exactly as planned, and soon they were heading eastbound on their long trip back to Kadena. It had not been a simple, straightforward mission by any stretch of the imagination, however.

Bad weather during two of the refuellings and a boom malfunction dictated that Terry had to maintain his contact position with the tankers for 3½ hours during the mission. To make matters worse, nine hours into the sortie he became temporarily blinded by the combined effects of pure oxygen and an overheat condition that affected his moon suit's faceplate. The simple task of reading his instruments appeared almost impossible without opening his helmet visor, but such action was out of the question due to the dangers of decompression and hypoxia. Terry recalls that by squinting hard he could produce tears. That small amount of moisture revived his vision enough to continue the long mission. He completed the sortie with a smooth night landing back at Kadena after flying for more than 11 hours.

Later in the summer of 1987, US intelligence believed that the Iranians had acquired a consignment of land-based HY-2 "Silkworm" anti-ship missiles from China. The weapon had a maximum range of about 60 miles and employed active radar homing to locate its target. In September 1987, the Iranians began launching the weapons from the Al Faw peninsula at Kuwaiti oil terminals around 50 miles away. Initially the weapons missed their targets and fell on uninhabited parts of the coastline, but on 22 October a Silkworm slammed into a Kuwaiti oil loading facility at Sea Island; its 1,100lb warhead caused extensive damage and triggered a



▲ SR-71A '974 hit the water inverted, causing the engines and heavy undercarriage to smash through its upper surfaces. (USAF)

major fire. Just four days after this attack, Majs Warren McKendree and Randy Shelhorse completed their first Gulf sortie, in aircraft '967.

Using surveillance information gathered from these flights and by satellite, US intelligence was able to determine the most likely positions from where future deployment of the Iranian "Silkworms" could threaten the Kuwaiti oil terminals. A brilliant civil servant and expert in decoys from the Naval Research Laboratory in Washington devised a simple and cost-effective solution to the problem by placing large corner reflectors on barges. Using the available imagery, these barges were then anchored between the likely launch sites and the potential targets.

On 7 December the Iranians launched a "Silkworm" against a Kuwaiti oil-pumping station. The decoy worked as planned. The missile struck one of the barge-mounted reflectors, its short fuse delay detonating the warhead and blowing the unit off the barge. The missile's target was completely unscathed, no one was injured in the attack and no further "Silkworms" were launched against the oil terminals.

Majors Dan House and Blair Bozek completed the last of these long-duration, high-priority missions in aircraft '974 on 30 April 1988. In addition to revealing the presence of Iranian "Silkworms", the sorties also gathered extensive intelligence about the masses of military equipment in the Gulf. Thus, intelligence services were able to forewarn the US Navy of the missile threat, and diplomats were able to bring pressure to bear on Iran. The SR-71 had again performed its intelligence-gathering service in a distant part of the world.

In earlier times, the crews would surely have received Distinguished Flying Crosses for these unique and important missions, but the sorties were being flown at the time when the Chief of Staff and other key SR-71 detractors were undermining the Senior Crown programme because of costs. The last thing they wanted were 'Habu Heroes'. Therefore, the crews were only awarded Air Medals.

CHAPTER 12

DET 4 OPERATIONS

GIANT REACH

Giant Reach was SAC's codename for SR-71, European-based, contingency planning of photo and ELINT reconnaissance-gathering operations. The original plan was to split this coverage and conduct both PHOTINT and ELINT of the Middle East and purely ELINT of Eastern Europe due to weather conditions, usually hostile to the collection of photographic imagery in northern latitudes. In order to execute these preliminary proposals, first published by HQ SAC on 6 April 1970, it was envisaged that five KC-135Qs would be deployed to Incirlik AB, Turkey and an SR-71 together with three 135s, and support personnel to be assigned to Torrejón AB, Spain, on a 30-day temporary duty (TDY) basis. However, the Spanish prohibited overt reconnaissance flights from originating from or recovering into their country, so that element of the proposal was modified and instead the SR-71 would be based at RAF Mildenhall, England.

During these early planning stages it was thought that the SR-71 would conduct between six to eight sorties during each deployment and the photoproduct would be processed by the 497 RTG at Shierstein, West Germany, while the ELINT and HRR 'take' would

◀ Due to a technical malfunction, Capt Harold Adams and RSO Maj William Machorek left Mildenhall a day later than planned, returning '972 back to Beale on 13 September 1974. (Bob Archer)

▶ European Theatre of Operations map showing estimated lines of Soviet ground assault.

be ferried back to Beale and analysed by the 9th RTS. However, additional funds to support such operations weren't initially available. Despite this, HQ USAF directed SAC to spend $50,000 from its operation and maintenance budget on alterations to the apron adjacent to hangar 538 at Mildenhall as a precautionary measure, in case the JCS directed that such sorties should go ahead; this construction work was completed in 1971.

The first operational requirement for European-based SR-71 sorties occurred on 6 October 1973 with the outbreak of the Yom Kippur War, bût, as covered earlier, the UK government of the day denied the Air Force use of Mildenhall in what ultimately proved to be a futile attempt to secure the continued supply of Arab oil. As a consequence, it was not until 1 September 1974 that the first Habu visited England. On that historic day, Majs Jim Sullivan and his RSO Noel Widdifield, flying SR-71 number '972, established a transatlantic world speed record from New York to London of less than 2 hours, a record that stands to this day (see Appendix 9 for further details). Thirteen days later, Capt 'Buck' Adams and Maj Bill Machorek set a return trip record to Los Angeles in the same aircraft of less than four hours.

To underline the partnership status of any future SR-71 deployments to the United Kingdom, Secretary of State Henry Kissinger instructed Mrs Anne Armstrong, the US Ambassador to Britain, to inform Her Majesty's Government that the US 'would of course be prepared to share with the British information produced by [such] SR-71 missions'.

Detailed route planning for any future SR-71 deployments to the UK was conducted by the Strategic Reconnaissance Center. They then sent details of three proposed tracks to the 98th Strategic Wing (SW) at Torrejón, Spain, as this unit was responsible for SAC operations from Mildenhall. Detachment 1 of the 98th SW, stationed at the UK base, then coordinated all necessary prior actions and notifications with the appropriate British officials.

ON THE GROUND

Expansion of Soviet ground and naval forces had a profound influence on future SR-71 operations within Europe. On the ground, Soviet and Warsaw Pact armed forces lacked the training and technologically advanced weaponry of NATO. Their advantage lay in overwhelmingly superior numbers concentrated into large numbers of armour, artillery and mechanized infantry divisions on a small number of narrow fronts that would drive deep into western Europe. American military planners doubted the ability of early NATO doctrine to stop such an offensive without the employment of tactical nuclear weapons, which in turn could easily escalate into a full-scale nuclear conflagration that could devastate not just Europe but the world.

The US experience in Vietnam indicated that attrition tactics were unable to achieve decisive results, at least in a politically acceptable timeframe, with politically acceptable losses. Rather than fighting while outnumbered and winning, a new concept emerged aimed at controlling the larger 'battle space' in order to reduce the strength and effectiveness of enemy forces prior to the moment of main contact between opposing ground forces. This called for interdicting the adversary's flow of men, materiel and supplies by using aerial assets, long-range artillery, and air mobility. By immediately taking the fight deep into the enemy's rear area, NATO could channel the attackers' movement, drive gaps into their formations, and deny follow-on echelons from joining the battle. This, it was anticipated, would disrupt both the enemy's momentum and its combat effectiveness, which in turn would force a 'culminating battle' in which NATO could manoeuvre to decisively counter-attack whatever had by then been identified as the enemy centre of gravity, thereby gaining the final decision.

N
Baltic Sea
North Sea
Kiel
Rostock
Lübeck
Wismar
Hamburg
NETHERLANDS
Bremen
Elbe
Wittenburg
POLAND
Weser
Berlin
Brunswick
Oder
Magdeburg
EAST GERMANY
Munster
Elbe
Dessau
Rhine
Essen
Dusseldorf
Kassel
Leipzig
Cologne
Erfurt
Jena
Dresden
Bonn
WEST GERMANY
Chemnitz
Koblenz
Frankfurt
Prague
Mosel
Mainz
Darmstadt
Main
LUX.
CZECHOSLOVAKIA
Nürnberg
Mannheim
Heidelberg
Rhine
Metz
Regensburg
Stuttgart
Danube
Strasbourg
Linz
FRANCE
Munich
Salzburg
AUSTRIA
0
100 miles
0
100km

Thus developed the US Army's so-called AirLand Battle strategy, which had four doctrinal tenets: initiative, depth, agility and synchronization. To execute these tenets, corps-level units were required to become the primary command communications (C2) headquarters, involved in both operational-level engagements and conducting the deeper attacks on enemy formations massing for combat up to 100 miles away by synchronizing artillery assets with air power. The overall battle space was partitioned into the Close Battle Area (up to 13 miles beyond the Forward Line of Own Troops or FLOT), the Deep Battle Area (which might extend to 120 or more miles beyond the FLOT), and the even more distant Strategic Battle Area.

The new army doctrine was aligned with close air support (CAS) concepts the US Air Force wanted to apply to its own evolving concept of deep battle. The air force had long resisted the reduction of airpower to the status of flying artillery, preferring instead to operate against strategic and other targets beyond the battlefield. Nonetheless, a close working partnership developed between the two services in forging the new doctrine. The SR-71's ability to execute highly effective PARPRO at extreme altitudes from within allied or international airspace, thereby acquiring vital reconnaissance data from deep inside Soviet borders, was key to US planners, as was the monitoring of Soviet/Warsaw Pact activity, particularly during the twice-yearly troop rotations.

On 20 April 1976, two KC-135Qs and the same SR-71that established the transatlantic speed records – aircraft '972 – returned once again to the UK, but this time the trip was made without the attendant media coverage that accompanied its earlier brief visit. Using the callsign 'Burns 31', Majs 'Pat' Bledsoe and John Fuller completed the flight from Beale to RAF Mildenhall in 4hrs 42mins. The key objectives of this deployment was for the aircraft to complete two training sorties; the first was to be flown over both the North Sea and Norwegian Sea and a second conducted over the English Channel and Bay of Biscay. These flights would both exercise the aircraft's base support facilities and help to shape the aircraft's flight profile and operating procedures that would need to be adopted when flying in the cramped airspace of Northern Europe. Such actions would pave the way for future SR-71 participation in NATO training exercises, the first of which was scheduled for later that same year.

Three days after its arrival, the first evaluation sortie got under way when captains Maury Rosenberg and Don Bulloch engaged both burners and departed the base. However, when they were to the west of Norway at 72,000ft, Bulloch discovered that the outside air temperature was 30° warmer than anticipated. After quickly recalculating the aircraft's performance values in this sub-Arctic environment by cross-correlating exhaust gas temperature (EGT) against inlet door position and interpolating the aircraft's true airspeed from the astro-inertial navigation system, the crew were alarmed to learn that their computed fuel specifics were way off the mark, and their actual fuel burn considerably higher than that calculated by the nav-planners back at Mildenhall. In fact, '972 was going to be 8,000lb lighter by the time they arrived at their air refuelling control point (ARCP), which in turn meant that they would barely be able to reach their tankers. The crew prudently decided to abort the mission and return to Mildenhall. The second training sortie was completed by Bledsoe and Fuller on 28 April, and two days later, using the callsign Kabab 31, Rosenberg and Bulloch returned '972 to Beale.

Two large NATO exercises kicked off in the autumn, Cold Fire '76, a land and air operation running from 7–10 September conducted in West Germany, and Teamwork '76, a land, sea and air exercise to be held in the North and Norwegian seas from 10–23 September. Headquarters European Command were keen that the SR-71 should participate in both exercises, pointing out that not only would this provide valuable training and logistical experience, but that it would also demonstrate 'positive US resolve in support of NATO'. Such participation would of course require authorization from several command authorities

as well as the UK Ministry of Defence (MoD), the JCS, United States Air Forces Europe (USAFE) and NATO member nations. Luckily negotiations to obtain prior approval for the SR-71 to overfly NATO countries and enter their airspace began early. As it turned out, the process was far from straightforward and took several months to complete – Denmark took it right to the wire and was the final country to grant its approval in early September.

▲ Majors Rich Graham (left) and his RSO Don Emmons completed the first SR-71 operational mission out of RAF Mildenhall on 7 September 1976. (USAF via Rich Graham)

The deployment of 962 began on 2 September 1976, but Al Cirino and his RSO Bruce Liebman had to divert into Goose AB, Labrador following engine trouble over the central United States. An emergency maintenance team was dispatched from Beale and the flight to Mildenhall was completed by Al and Bruce four days later. Majors Rich Graham and Don Emmons flew the following day in support of Teamwork '76 and incorporated lessons learned from the previous deployment; they successfully completed the first operational mission over the Barents Sea before recovering safely back to 'The Hall'. Then it was Al and Bruce's turn. They were tasked to fly into West Germany in support of Cold Fire '76, which again they successfully completed in 962. In total six sorties were flown and HRR imagery, photography and ELINT was collected from the exercise areas before Rich and Don returned the aircraft home after a European tour lasting 19 days.

Before the next Habu deployment to the UK, a change in SAC's European reporting structure took place following Senate ratification of a new treaty with the Spanish government in January 1976, which stipulated a reduced American military presence in that country. Consequently on 31 December 1976, the 98th SW was deactivated. Command was transferred to the 306th Strategic Wing, which had been activated four months earlier and co-located with Headquarters USAFE at Ramstein AB, Germany. General Richard Ellis, Commander in Chief USAFE, and CINCSAC, Gen Russell Dougherty, whom Gen Ellis succeeded as the SAC Commander on 1 August 1977, had had extensive discussions in the months leading to this command restructure and had formulated a plan that would have a profound impact on the build-up of SAC assets in Europe.

It had been decided that the 306th SW commander would report directly to the CINCSAC and his staff, and that he had 'delegated authority' to exercise the CINCSAC's command responsibilities for all present and future SAC European operations. These related to the European Tanker Force, the RC-135s that were TDY with the 306th SW's detachments at Mildenhall and Hellenikon AB, Greece, as well as any future B-52 or U-2R/SR-71 deployments.

The desire to increase SAC's presence in Europe had its roots in the changing nature of the Soviet/Warsaw Pact threat facing NATO. General Ellis wanted B-52s to deploy periodically to England, together with their support tankers, in order to train such a force to a level that was capable of performing a wartime tactical mission: this, he envisaged, would consist of interdiction both in the vicinity of the battle area and beyond its forward edge, as well as airfield attack, defence suppression, sea surveillance and anti-shipping. It followed, therefore, that if B-52s were tasked to perform a mission similar in nature to that which they had flown for eight years in South-East Asia, the U-2R and SR-71 would again be required to provide complementary pre-strike and bomb damage assessment imagery in addition to SIGINT warning information. An additional issue of particular concern to Gen Ellis was the

unprecedented level of sophistication that accompanied the twice-yearly Soviet-Warsaw Pact exercises that had began on 31 December 1976. Specifically he noted, 'Of particular interest to us at SAC is their coordinated and extensive use of airborne command posts as alternate command centres and their ability to control forces when required, particularly during/after a global nuclear exchange'. On balance therefore, it's perhaps not surprising that as far as the general was concerned, it was 'most desirous' that the SR-71 and U-2R deploy to RAF Mildenhall to monitor these exercises.

The third SR-71 training deployment was completed by serial '958, which arrived as Ring 21 on 7 January 1977: Rich Graham was again at the helm with Don Emmons 'in the back'. In support, two KC-135Qs transported 65 maintenance, operations and logistics specialists, together with 80,000lb of equipment. Col John Storrie, the 9th SRW commander, also accompanied the deployment to inspect for himself Mildenhall's support facilities. This 10-day deployment was timed to coincide with the approximate date of President Jimmy Carter's inauguration, and it would thereby underline the United States' continued support of its NATO allies. Two training sorties were again flown by the SR-71, covering the same sea areas as the April 1976 deployment. Majors Tom Alison and his RSO J. T. Vida made up the second SR crew on this deployment, and it was they that repositioned the aircraft back to Beale as Paver 86.

In late February 1977, Headquarters SAC proposed to the JCS that they seek approval for another SR-71 operational deployment to Europe. It was proposed that the 17-day tour should consist of one training sortie, similar to the two completed in January 1977, and two PARPRO missions. The first of these would be a coordinated sortie with a Mildenhall-based RC-135V and flown along the Barents Sea periphery, while the second sortie would be flown over West Germany. SAC requested that both of the PARPRO missions be approved to collect ELINT and HRR imagery, since they were particularly anxious to demonstrate the unique characteristics of the latter to other potential national intelligence users. While the proposal navigated its way through the JCS evaluation process, the SRC worked on preparing the aircrafts' tracks in anticipation of receiving an affirmative for the deployment. The JCS duly issued SAC with the necessary authorization to proceed on 6 May 1977; they also instructed that the SR-71 was to adhere to tracks prepared earlier in the year by the SRC, as these had been used by the State Department to coordinate and obtain the necessary clearances from five NATO nations through whose airspace the SR-71 would fly. The JCS also went on to direct Headquarters SAC to deploy to Mildenhall a Mobile Processing Center (MPC), held in storage at Beale. This last instruction was issued in response to a request from Gen Ellis, and as such had been anticipated by SAC.

THE MPC

In 1977, two MPCs existed; in addition to the one alluded to by the JCS, the other (MPC I), was in caretaker status at Kadena AB. Each MPC consisted of 24 trailer-like vans that measured 8ft x 8ft x 40ft and collectively contained all the equipment necessary to process raw intelligence data collected by the SR-71's HRR and cameras. (MPC I was also equipped with an Electro-Magnetic Reconnaissance (EMR) formatter that processed the ELINT tapes; however, at a cost of over a million dollars each (mid-1960s values), it had been decided that only one MPC would have this additional capability, and this was installed in the unit located at Kadena.) The MPC could be deployed overseas in various tailored packages or van combinations to support different levels and types of reconnaissance operations. The complete package was designed to support one SR-71 mission per day and required an operating staff

▲ SR-71 958 deployed to Mildenhall from 16–31 May 1977. (Bob Archer)

of 60 officers, airmen and civilian contractors. Depending upon the amount of data collected, typically photography and HRR imagery was available to the interpreters four hours after the Habu had landed (MPC I also afforded top-line ELINT signals ready for first-stage analysis in about three hours). The entire 24-van package of MPC II destined for Mildenhall weighed in at 290,000lb and was transported to the UK in two C-5s and four C-141s: transportation costs were picked up by USAFE, but manpower and payment for expendable supplies came from SAC monies already allocated. On arrival in the UK, MPC II was located inside a secure compound within hangar 538, and at great credit to all involved the facility was operational when Indy 69, aircraft '958, touched down at the UK base on 16 May 1977.

OPERATIONAL DEPLOYMENT TO THE UK

Buz Carpenter now describes the positioning of Indy 69 to the UK.

John Murphy, my RSO, and I had just completed our first tour overseas at Kadena AB, where we had flown our first operational SR-71 missions. This is where all crews first went after they had completed their year of training at Beale AFB and where you were closely supervised and guided through your first few missions, both training and then operational.

Returning from Kadena we felt we were too junior to be eligible to deploy to England for these missions. Precedent had always been that the senior crews executed these missions from Europe or any other new locations; however, Col Willie Lawson, then director of operations for the 9th SRW, decided that to keep the SR-71 crew force balanced in experience and time away from home, he would allow newer crews who had completed their first Kadena tour to be in the pool to meet these new tasks.

John and I were delighted and honoured as the most junior crew when we were told we would fly the SR-71 to Mildenhall and stay there for this deployment. We were both excited about this opportunity and most appreciative of the confidence Col Lawson had put in us.

▼ Part of the 24-van MPC II, located within a secure compound inside Hangar 538. (Paul F. Crickmore)

The mission to England was not any longer than any mission we had already flown with two refuellings. Differences lay in the arrival procedures for the SR-71 entering the United Kingdom and the airfield familiarity of Mildenhall itself. Because of English weather conditions we normally departed California at about 2:00am, which after two refuellings and two hot legs in the 4-hour flight got you into England in the middle of the afternoon.

These missions were supposed to be secret and had been coordinated through the special offices in each of the FAA regional centres we would fly through until entering Canadian airspace. Canadian air traffic centres provided this same level of special support. This idea was to protect our route of flight and also to keep our destination unknown. Secrecy was supposed to be a very important mission factor. We went into work the day before departure, as always, to plan the mission and to get everything checked out. Later in the afternoon, we each took a sleeping pill to ensure we got the required crew rest. Around 11:00pm we awoke and headed to the Physiological Support Division for our pre-flight physical, pick up our mission materials, have our pre-flight meal of steak and eggs and meet with the back-up mobile crew to determine the status of our aircraft. Suiting up started around 1 hour before take-off so that we could arrive at the aircraft about 45 minutes before our 2am take-off slot.

As I remember, everything went smoothly until I discovered that my helmet face heater was not working after I had been strapped into the aircraft, which caused my glass faceplate to completely fog over. Spares were normally available and a replacement helmet was quickly found and installed on my pressure suit. We then blasted off into the darkness at exactly the prescribed time of 2:00 in the morning. About 150 miles from Beale out over the Nevada desert we hooked up with our awaiting tankers at 25,000ft. During the refuelling we took on about 60,000lb of fuel (8,000 gallons plus) and dropped off the tanker over Northern Utah and started our climb and accel. Passing through 60,000 we would routinely call the Air Traffic Centre as we turned off our electronic altitude reporting at this point. Salt Lake Centre said, 'Roger Indy 69, have a great time in jolly old England'. So much for mission security! We had not said anything, so we felt we would be exonerated. Cruise leg was uneventful as we passed over the northern United States and into Canadian airspace at Mach 3.0 and above 75,000ft. I remember it was a moonless night, which when flying over thinly populated areas gives you an opportunity to see a vast array of twinkling stars that you don't see on the ground because of their lack of intensity and the atmosphere filters them out.

As we approached the Canadian east coast near Goose Bay, Labrador, the sun was starting to rise as we were descending and decelerating. This particular condition was wonderful to view from 75,000ft, yet it was one of the most difficult refuellings, because as you were under the tanker at 25,000ft, trying to maintain your position and monitor the tanker refuelling director lights on the belly of the aircraft, the sun was just above the horizon and right in your eyes. It blinded you, even with your helmet sun visor down. With the refuelling done, we then separated from the tanker again and started our climb and acceleration eastward over the Atlantic and on into Scotland. As we crossed, Greenland was partly visible and a couple of huge icebergs were seen slowly floating south. Iceland was completely shrouded in clouds, as usual, and the weather in England was going to be overcast and rainy.

Our descent and deceleration was normal and brought us over England subsonic, and we proceeded south and east to Mildenhall. About 50 miles out we made contact with our mobile crew for recovery, Tom Alison and J. T. Vida. They advised us of the weather and to look for the birdwatchers. Initially John and I were puzzled by the

birdwatchers remark. As it turns out, about half an hour before our arrival, a couple of hundred aircraft birdwatchers showed up with their cameras to photograph our arrival! Again, so much for security involving our flight over. The birdwatcher net sure trumped our security plan.

Arrival was uneventful and after a precision approach I chose to take the aircraft around for one visual approach. One could see birdwatchers with their cameras at all the opportune spots around the airfield fence. Some even waved to us as we taxied to our parking hangar!

On 18 May, '958 satisfactorily completed the JCS-directed training sortie over the North Sea. The aircraft was configured with the same sensor package that it would carry aloft during the two operational missions, namely the nose-mounted HRR, ELINT sensors in the two aft mission bays (bays S and T) and a full DEF system.

MAY 20, 1977

Tom Alison now recollects the coordinated mission with the RC-135 over the Barents Sea.

J. T. Vida, my RSO, and I arrived at RAF Mildenhall via a KC-135Q along with the TDY detachment commander, Colonel Willie Lawson, and the nav/planner, Lt Col Red Winters. This particular mission was tasked at the Top Secret level to make two passes using High Resolution Radar imagery and ELINT sensors against the Soviet Union naval submarine base at Murmansk on the coast of the Barents Sea; it was also scheduled as a coordinated mission with an RC-135V 'Rivet Joint'.

It was a little unusual for a PARPRO mission to be classified Top Secret, but J. T. and I just thought that was because it was a coordinated sortie and one of the first to go in the area around Murmansk. It may also have been due to the fact that the Soviets had deployed the SA-5 surface-to-air missile in the Murmansk area and it would be one of the first occasions that the SR-71 had been used in an area where there were known SA-5s, a much more capable SAM than the SA-2, which was widely deployed and was not considered an extreme threat to the Blackbird.

During the mission planning session the day before, it was discovered that the Soviets had issued a Notice To Airman (NOTAM) warning of surface-to-air missile test firing from the surface to in excess of 100,000ft. The coordinates of the area were off the coast of Murmansk, and bracketed very nicely the only place on the mission where we would fly through the same area twice, going in and coming out. We were always concerned about prior awareness relating to SR-71 missions, and this seemed like a highly improbable coincidence. Maybe, somehow, the word about our mission had leaked.

Although at the time J.T. and I were not really aware of it, it seems that in some quarters this possible security leak caused quite a bit of concern. Apparently there were several secure phone calls made between RAF Mildenhall and the SAC Strategic Reconnaissance Centre, and the discussion centred on whether or not to cancel the mission based on the NOTAM. It should be noted that the mission track was planned entirely in international airspace. If we stayed on the 'black line' we would never enter Soviet airspace. However, that said, the mission was planned to obtain maximum information concerning the submarine activities and area defences. At one point during the second pass through the area, the Blackbird was planned to be heading

▲ An RC-135V Rivet Joint of the 55th SRW, similar to that pictured, took part in a coordinated mission with SR-71 '958 over the Barents Sea on 20 May 1977. (Bob Archer)

▶ Majors Tom Alison (left) and his RSO J. T. Vida flew the first operational SR-71 sortie from RAF Mildenhall, coordinated with an RC-135. (USAF)

directly at the submarine base, perpendicular to the coastline at Mach 3.15. At a certain point we began a high bank turn that would put us parallel to the coastline headed out of the area. That point was right in the centre of the 'missile-firing box' outlined by the NOTAM.

The concern centred on whether the Soviets would actually fire an SA-5 against an aircraft in international airspace. 'Intent' was always a key word in a situation like this. Another concern was that the SA-5 was new and relatively unknown in terms of RF indications and performance. We were later told that Kelly Johnson was actually part of the conference and his position was that we should not fly the mission as scheduled. In the end, though, it was determined that the sortie would be flown as scheduled.

The following day we all got airborne on time, the RC, the 'Q models', and the Blackbird. Our mission profile was normal through the refuellings, but as we began our climb and acceleration to Mach 3+ cruise prior to entering the target area it became obvious that the outside air temperature was much higher than we expected and were used to. This causes the climb/accel to be slower than normal. It was so hot, and our performance so degraded, that at the point where we should have been level at Mach 3.15 and 75,000ft, we were just passing 60,000ft and still climbing, and we were only accelerating through about 2.8 Mach. J. T. and I were discussing our situation and he mentioned that the radar sensor had just come on. We had never had it come on while we were still climbing before. Additionally, the slower performance caused us to be well below the planned fuel curve. Decisions, decisions.

We decided to press on and finally got levelled off and up to our desired cruise speed. We actually pushed the Mach up a little to try and help ourselves get back on the fuel curve. Although I knew we would never be able to make up all of it, I was comfortable that we would be able to get back to the tankers for the next air refuelling – if nothing else went wrong. And, in fact, that is just what happened. We completed both passes through the target area, and the missile firing warning area, with very little reaction noted on our defensive systems. The last air refuelling and the trip back to Mildenhall were uneventful. Just the way we liked it.

During the debriefing following the flight, we received word that we had already had a very successful mission, and our radar take had not even been processed yet.

It seems the RC-135 Rivet Joint, which was in the target area for some time before we arrived, had quite a bit of Soviet company in the form of interceptors. At the point in time where we were beginning to enter the area, the RC crew became aware that the interceptors abruptly departed and the linguists monitoring the radios overheard the Soviet GCI trying to vector the interceptors to the SR-71. At least one interceptor pilot was heard to say, 'I can see the contrail above and ahead. It is climbing at a very high speed and I will not be able to catch it.' Heck, we already knew that!

Further adding to the initial success of the mission was the first ever capture of specific RF signals associated with the SA-5, which was picked up by both our systems and the systems on the RC. J. T. and I had spent 45 minutes in the 'denied area', most of it at a little in excess of Mach 3 – just another day at the office.

Total mission time was four hours two minutes, of which 45 minutes was spent completing the two reconnaissance-gathering passes.

24 MAY MISSION

Buz Carpenter recounts the operational mission over West Germany.

Next flight up was for John and I to fly the tricky German mission. Like the Baltic mission, one could not fly the aircraft at Mach 3.0 and make the turns to stay within the country border limits imposed upon us. In both cases, while flying at Mach 2.8 a maximum 45°-bank high angle turn was required to stay within the confines. Because of aircraft energy management, a slight descent was sometimes required to maintain the 45° of bank and 2.8 Mach. These turns were therefore planned for 42°, which gave you an additional 3° to use to maintain your critical ground track. The problem was, the steeper the bank, the more likely the loss of altitude in the turn. If you were flying in warmer than standard air temperatures, it further aggravated this energy management balance. Often we would descend a couple of thousand feet just before the turn to give ourselves an energy advantage.

To provide as much secrecy as possible, the mobile crew would reaffirm our take-off time and that our flight clearance was ready. With this check complete, we would initiate our engine start and aircraft systems check without any radio calls about 30 minutes prior to take-off. The Mildenhall control tower would flash a light to signal our clearance to taxi and to enter the runway for take-off. With the UK airspace de-confliction completed, a green light would be flashed to us from the tower and a radio silent take-off would then occur.

Traffic had been cleared from our path and we climbed unrestricted to 25,000ft and headed out over the North Sea to meet our tankers. When the refuelling was completed, we executed a right turn to the southeast and initiated our climb and acceleration.

Our entry target was to cross the German coast near Wilhelmshaven at Mach 2.8 above 70,000ft. Our heading was almost due south, towards Kaiserslautern, avoiding overflying major population areas. Below us most of the ground was covered with low clouds. This track was followed by a 30°-bank turn to the southeast, passing southwest of Stuttgart and heading into Bavaria. Here the cloud cover broke and the landscape was a wonderful patchwork of little villages, agricultural fields, and mountainous terrain.

▲ Majors Buz Carpenter (left) and his RSO John Murphy ferried '958 to Mildenhall and conducted an operational sortie along the East/West German border. (USAF via Buz Carpenter)

Now came the difficult manoeuvre to ensure that we maintained our track inside of West Germany, while flying south around Munich while executing a 45° high-bank turn. Luckily, during his particular day there were some clouds below and the cooler than standard upper air temperatures enabled us to maintain our altitude. During these turns, as much as one would have liked to have taken advantage of the spectacular views out of our down side turn window, full concentration was required to make sure one executed this high bank turn exactly as planned – maintenance of the ground track was paramount, as this had been promised to America's National Security leadership. Bank angles, Mach stability, engine performance, absolute ground track, and all other aircraft systems had to be intensely monitored to start corrective actions if deviations became apparent. Nothing would be said in the turn unless it was essential to this turning process. The 180° plus turn placed us north of Nuremberg, flying northwest beside the inner German boarder.

Basically our sensors ran the whole time along the inner German border objective area. Once abeam Frankfurt, passing to the north, a turn north was completed to align us to depart Germany in the same coastal vicinity we had entered less than an hour earlier.

Once clear of the coast, we started a 30° descending turn to the southwest. It took over 200nm to start a descent, decelerate and level off at 25,000ft inbound to England. There was not much margin for error or any type of delay in the close confines we were operating in. This all happened very quickly, as descents were another high-activity time period to make sure the aircraft maintained those narrow flight parameters to allow for a safe descent. Engine compressor stalls could occur with engine flameouts if your tight descent profile was not maintained. Once below 2.4 Mach the profile became more flexible and at 1.8 Mach, with the inlet spikes full forward, there was even more latitude. This whole descent was designed to be ready to enter the English landmass subsonic. Approaching England we would then break radio silence and contact Northern Radar and follow their guidance for an instrument recovery back at Mildenhall. English air traffic control sector radar controllers and, when required, their precision radar approach controllers, were superb – this in part may be because of all the practice they receive with England's notorious weather!

From operational missions a single approach full-stop landing was always planned. After landing and deploying our huge orange drag 'chute, slowing was closely monitored and once below 80kt, the drag 'chute would be jettisoned if there was not a severe crosswind. As we taxied in front of our parking hangar, the sensor crews were already in place to immediately down load the sensors and process what we had collected after we had stopped. As the engines were shut down, sensor crews were already under the aircraft opening hatches and by the time John and I stepped from the cockpit most of them had already been down loaded – mission duration was two hours 22 minutes.

Aircraft systems and anything unusual from the mission was debriefed at planeside before we were driven back to the PSD building and de-suited. This would be followed by extensive debriefs and then it was our turn to assume the mobile back-up position for Tom and J. T. for their next scheduled mission.

▲ On its flight from Beale to Mildenhall on 24 October 1977, '976 participated in a coordinated mission over the Barents Sea with the RC-135U Combat Sent II. (Bob Archer)

As a postscript, about two weeks later we were informed that our TDY at Mildenhall had been extended to support the Air Tattoo celebrating the Queen's Silver Jubilee. A two-day open house would attract well over 100,000 visitors and the SR-71 would be on its first British public display since setting the speed record from New York to London in 1974.

The SR-71 would be part of the static display, but roped off so people could not touch the aircraft. We had been advised to watch for representatives from the Soviet Union and Eastern satellite countries trying to get too close to the aircraft and securing material samples. To prevent the Russians or anyone else from exploiting the display, no sensors were left on the aircraft, all fuel had been removed from the tanks and the aircraft was heat soaked to ambient temperatures to prevent infrared cameras from discovering the secrets of the aircraft's internal structure and support systems.

As we four crewmembers were standing around the aircraft answering questions from the crowd, sure enough the Russians showed up in numbers. They took numerous regular and infrared photos and some of the Russians even had hidden microphones. They were a sight to see, coming up like a covey of quail. It looked like the Salvation Army had outfitted them. Their dress sense was that from a 1930s movie about American mobsters. They were attired in bulky double-breasted suits made from rougher cloth than one normally sees, and all clustered around each other waiting for their leader to act. The head of the Soviet delegation, a former MiG-23 fighter pilot, was quite relaxed and talkative in his demeanour and invited John and I to sometime drop in on Vladivostok in the Far East as a gesture of peaceful relationships. We just quipped, 'Please forward that request to our State Department.' The British open house audiences are much more aviation literate than their American counterparts. Tough aeronautical questions were often asked as we stood by the aircraft in the static display, but a great time was had by all, with wonderful weather and spectacular flying demonstrations.

On 31 May 1977, Tom and J. T. redeployed '958 back to Beale AFB using the call sign Resay 35.

ANOTHER RESTRUCTURE, ANOTHER DEPLOYMENT

To improve command and control of its forces in Europe and to further strengthen liaison between the CINCSAC and the US and allied commanders in Europe, Headquarters SAC

▲ Photographed on 24 October 1977, RC-135U 64-14849 climbs out from Mildenhall en route for the coordinated mission with '976. (Bob Archer)

activated the 7th Air Division at Ramstein AB, West Germany on 1 July 1978 as a direct reporting unit. It also moved 'on paper' the 306th Strategic Wing from Ramstein to RAF Mildenhall, which until this date had been Detachment 1 of the 306th at the UK base.

Even before the Habu's first European operational deployment had begun, planning was already under way for a second, which was scheduled to occur in the autumn of 1977. European commanders were anxious that the SR-71 should again participate in exercise Cold Fire; however, recce specialists at HQ SAC were sceptical as to the value of such an exercise, mindful of the limitations imposed upon the aircraft's sensors when forced to adopt a highly restrictive flight profile in order to conform with political considerations based upon Switzerland, Austria and France's decision to deny the SR-71 clearance to overfly their airspace.

However, the success of the first deployment ensured that Maj Gen Earl Peak's (SAC Deputy Chief of Staff for Operations) request to the JCS for an October/November deployment was approved. The year's second PARPRO deployment was planned to leave Beale on 20 October 1977, fly eastward from Beale over the Arctic Circle and conduct a coordinated intelligence-gathering sortie with the RC-135U Combat Sent II, serial 64-14849, in the Barents Sea, before recovering into Mildenhall. (64-14849 flew 30 operational missions into the Baltic and Barents Sea areas during this, its second, or Papa deployment to Mildenhall in 1977.) However, due to bad weather at Thule AB, Greenland – the SR-71's nominated emergency recovery base for this deployment – the mission was delayed for four days and Capt Joe Kinego and his RSO Maj Larry Elliott completed the 5-hour 49-minute mission to Mildenhall in aircraft '976 on 24 October. During the sortie, Joe firstly conducted a post-take off top-up near Edmonton, Saskatchewan, Canada; a second AR was completed near Greenland and a third after the take, off the coast of Norway.

During this tour it was planned to fly several more sorties than on previous UK deployments; consequently, two additional Habu crews arrived via KC-135Q tanker to gain valuable experience in operating in this unique environment. They were Bob Crowder and John 'Jack' Veth, together with their respective RSOs, John Morgan and Bill Keller.

Between the three crews, eight round-robin sorties were flown into West Germany, on 27 and 29 October, and 1, 3, 6, 7, 10 and 11 November. The average mission time for these sorties was 2 hours 38 minutes, and involved one air refuelling over the Wash, a large bay-like area off the northern coast of East Anglia, shortly after take-off. The route consisted of just a single pass along track X-027, which was aligned parallel to the East German/

▼ Majors Jay Murphy and John Billingsley deployed '964 to Mildenhall on 24 April 1978. Note the dark green Buick start cart, parked under the aircraft's left wing and used to crank the engines. (Bob Archer)

Czechoslovakian borders, specifically to monitor the Soviet/Warsaw Pact autumn troop rotation. Headquarters EUCOM requested that SAC direct the SR-71 to collect as varied an ELINT/HRR sampling as possible. Consequently, the 3 November mission launched after sunset and completed a night sortie, a practice seldom undertaken because of noise considerations.

On 16 November, as Dew 49, Bob Crowder and John Morgan returned '976 to Beale. Having left Mildenhall, Bob first topped off over the North Sea; he then completed another coordinated sortie, with RC-135V 64-14849, spending 45 minutes collecting intelligence in the constrained geography of the Baltic Sea. They then completed a second AR over the north coast of Scotland and a third off the east coast of North America before touching down at Beale after a flight lasting 6 hours 11 minutes. Throughout the deployments in 1977, both the SR-71 and the MPC performed flawlessly.

▲ SR-71 '976 deployed to Mildenhall from 24 October to 16 November 1977. Note the 9th SRW insignia on its fin. (Lindsay Peacock)

On 24 April 1978, Justin 'Jay' Murphy and RSO John Billingsley deployed aircraft '964 to Mildenhall to cover the spring troop rotations. During the 16-day period of its stay, two crews flew the aircraft, Bob Crowder and John Morgan ferrying it back to Beale on 12 May.

INCREASED INTEREST FROM THE US NAVY

US Navy planners believed that the Soviet Navy would challenge the United States on the high seas by using its attack subs to threaten the vital sea lines of communication (SLOCs) used by merchant shipping to resupply Europe, just as the German U-boat fleet had done in World War II, thereby forcing the US Navy into a defensive role.

However, to reach deep water the Soviet Navy had first to overcome some fundamental geographical constraints. For example, if Soviet forces wished to sortie against NATO's SLOCs in the Atlantic, they'd need to route around Norway's North Cape and travel southwards down through the Greenland-Iceland-United Kingdom (GIUK) gap. Another possible alternative was to route through the narrow and shallow waters of the Baltic Sea's western exits, or out of the Black Sea through the Turkish-controlled Bosporus and into the Mediterranean, which was even more confining. In the Pacific, vessels leaving Soviet ports were less restricted, but would still need to deal with surveillance and naval forces based in Japan and the Aleutian Island chain. In Europe, therefore, US naval planners were particularly interested in the five naval bases at Zapadnya Litsa, Vidyayevo, Gadzhievo, Severomorsk and Gremikha (home of the Northern Fleet).

Leveraging these geographical constraints to full advantage, in the late 1950s the US Navy developed a Sound Surveillance System (SOSUS). It used underwater, passive acoustic-detection devices able to detect the low frequency sounds radiated by vessels, sending such data via cables running on the seabed to one of six US Navy shore-based processing facilities for analysis. With every vessel having a unique acoustic 'fingerprint' the US Navy collected a vast library of acoustic characteristics, or acoustic intelligence (ACINT).

By the mid-1970s, the Navy Ocean Surveillance Information Center (NOSIC) at Suitland, Maryland, had developed a computerized database that correlated specific sound characteristics with individual oceangoing vessels or submarines – a process known as hull-to-emitter correlation (HULTEC). Using ACINT and other monitoring systems, US naval intelligence was therefore able to monitor the comings and goings of Soviet missile-carrying

"Golf", "Hotel" and "Yankee"-class submarines as they transited from their home ports to and from their patrol areas off the US east and west coast seaboard.

Under the leadership of Admiral of the Fleet of the Soviet Union Sergei Gorshkov, the Soviet navy became a powerful blue water fleet, capable of projecting power outside Soviet home waters and challenging Western naval power. In 1973, the Soviet Navy commissioned the first "Delta"-class nuclear-powered ballistic missile submarines (SSBMs, or 'boomers'). Depending on the specific variant, "Deltas" carried between 12 and 16 R-29 submarine launched ballistic missiles (SLBMs), which touted a range of 4,780 miles.

By the spring of 1978, a group of young analysts at the Office of Naval Intelligence (ONI) had become aware of a drop in ACINT in what appeared to be a fundamental shift in Soviet naval strategy. With the "Deltas" now in service, it seemed increasingly likely to these analysts that instead of running the gauntlet of SOSUS arrays positioned at known choke points, the Soviet Navy was intent on establishing the Barents Sea and areas off Vladivostok and Petropavlovsk as highly defended 'bastions' that were effectively no-go areas to US or allied naval forces. From these year-round ice-free safe havens, the Soviet SSBM fleet could fire its lethal nuclear missiles at targets within the United States with relative impunity. This doctrinal protection of the Soviet submarine fleet sought to preserve a favourable correlation of forces at the end of any initial nuclear exchange.

Understanding this new Soviet naval strategy enabled the US Navy to respond by developing the so-called Maritime Strategy. This sought to make victory possible in a war against the USSR in three principal ways: by destroying as many SSBNs as possible, thereby reducing the nuclear threat to the United States; by launching strikes on Soviet targets from US carriers; and by tying down the Soviet fleet in static defensive operations in the far north, thereby preventing it from causing mischief elsewhere. This aggressive forward-focused naval strategy would also, it was hoped, prevent Soviet naval aviation from bolstering support of ground forces intent on any offensive operation in Europe.

Central to the viability of the Maritime Strategy was a requirement for the ONI to have an accurate 24/7 fix on the position of every Soviet SSBM. But surveillance of the ports from where these powerful subs would sail was particularly difficult, even for satellites, due to the prevailing weather conditions, which for the most part consisted of persistent cloud cover, rain and fog; of course there were also the long, dark Arctic winters; even on clear days, the sun angle in the Barents Sea was often too low for the collection of high-resolution photography.

In May 1978, mindful of the SR-71's HRR/RADINT gathering capabilities, Admiral James A. Holloway III, Chief of Naval Operations (CNO), requested that the DIA validate a requirement to use the aircraft for naval intelligence. The DIA's evaluation indicated that seven such missions per month would be needed to fulfil the Navy's requirement, but it recommended that the SR-71 should first fly several evaluation sorties. In 1978 the number of PAA SR-71As stood at just eight aircraft, and with commitments in the Western Pacific, to the SIOP, the Strategic Projection Force, the two or three annual deployments to Mildenhall and training operations at Beale, it was thought that the level of coverage required by the CNO was well beyond what was possible with the number of SR-71 assets then available, so the matter was put on hold.

On 16 October 1978, '964 again deployed to Mildenhall, under Rich Graham and Don Emmons. This time the stay lasted 16 days, and BC Thomas, together with his RSO Jay Reid took turns with the Stan/Eval crew to collect RADINT and ELINT of the troop rotation, but neither ventured into the Barents Sea. Instead, Kadena-based SR-71s collected RADINT of the Soviet's Pacific Fleet around Vladivostok and Petropavlovsk for the CNO.

YEMEN

In early 1979, the established cycle of SR-71 European deployments during the spring and autumn was interrupted and increased by the threat of yet another war in the Middle East.

Situated on the tip of the Arabian Peninsula and at the southern approach to the Red Sea, North and South Yemen bordered oil-rich Saudi Arabia. One of the few Arab nations friendly to the United States, Saudi Arabia was the largest foreign supplier of oil to the US.

Throughout the 1970s, South Yemen had received military aid from China and the Soviet Union. In addition, it had repeatedly tried to undermine the more moderate government of North Yemen. Saudi Arabia had close ties with North Yemen, but not with the left-wing government to the south. On 24 February 1979, while the South Yemeni foreign minister was in Riyadh, pledging that his government would support Arab League arbitration over the problems that existed between North and South Yemen, his country invaded its northern neighbour.

It was an action that caused considerable consternation within the Saudi royal family, which feared that a united Yemen under a Marxist government would infiltrate and seek to threaten their country's already fragile political stability. So, in response to a Saudi request made through the DIA, the JCS directed HQ SAC to deploy an SR-71 to Mildenhall on 12 March 1979, one month before the scheduled deployment to cover the spring Warsaw Pact troop rotation. It was tasked to conduct a single Giant Reach special mission into the Middle East and secure surveillance relating to events in this latest hot spot.

Despite a 3 March ceasefire that supposedly came into effect between North and South Yemen, intelligence sources advised the DIA that fighting had continued, particularly in the regions of Qatabah and Harib. As a result, the JCS's earlier decision to deploy still stood.

Back at Beale AFB, the saga picked up with the arrival of a SAC Operational Readiness Inspection (ORI) team. The team chief was none other than Brig Gen Pat Halloran, former 9th Reconnaissance Wing commander, SR-71 pilot and flight instructor. Buz Carpenter takes up the story:

> For the aircrew members this was normally not much of a challenge, since most of the SAC inspection team members weren't cleared to see the classified aircraft systems and particularly our ongoing peacetime missions. During this period we were flying 10–15 operational missions a month, from Beale, Kadena and occasionally Mildenhall.
>
> So instead, we would take an aircrew bold face emergency action checklist test: all checklist items had to be from memory and errorless in order to pass. Maintenance had to generate all the aircraft as if they were to be flown and deployed. We would inspect the aircraft and bring each SR-71 up to the engine start configuration and then the inspection team would certify the aircraft as generated and ready. Other weapons systems had to actually launch their aircraft and demonstrate flying and weapons delivery activities, plus their ability to execute their assigned missions; we were scored on the actual success rate on the operational missions we had been tasked for during the previous two years. Our average was always above 90 per cent, which always gave us an outstanding mission execution rating.
>
> The SAC ORI team arrived on Wednesday, as I remember, and we completed aircrew testing on Friday, together with acceptance walk-throughs on the generated aircraft. An aircrew or two was normally selected to conduct a simulated mission in our incredible computer-supported simulator. For its time, it was one of the most

advanced mission simulators in the USAF. One did not even need an instructor on the console; as the aircrew executed actions, the simulator knew how the aircraft would react and 'put the aircraft' into that environment.

There was going to be an aircrew 'solo' party that Saturday night, so a number of us thought it would be fun to go up to the Reno air races on Saturday for the day. Much to our surprise the squadron commander said we needed to stay on base and if we had to leave the base, we had to stay in the local area and in touch with the squadron (this was pre-cellphone days, so it was a much tighter leash for all of us). We thought that this was rather unusual, because basically our part of the ORI was over.

On Saturday everyone stayed close to base and that night we had the 'solo' party. It was customary during SR-71 flight training that as the pilot and RSO first flew together and then completed their first Mach 3+ flight, they would individually host an open bar at Beale's officers' club. This was not an insignificant bill, but one everyone was delighted to step up because of what it signified. When the crewed pilot and RSO were far enough along in their training that they were now flying together, they would host a party for the crew force and key staff members. This particular Saturday was one such event.

As people were moving around congratulating our newest aircrew and exchanging whatever flying stories of the day, one could detect rumblings of something happening in the background. There was trouble somewhere in the world and an initial planning call must have been made to the SR-71 organization to get ready for action. Speculation was rife and the same old questions were being asked: 'Where is the trouble? Are we officially tasked? Where might we be deployed to execute these mission(s) from?' aAnd of course, most importantly, 'Which crews are likely to be selected to support this effort?' As bits and pieces of information were revealed, a picture and a timeline formed for deployment action probably within the next week … but the only thing we knew for sure was that we'd be heading east from California to deal with the crisis.

At about 10:00pm and with the party in full swing, Col Willie Lawson, the director of operations for the SR-71 programme, came up to John Murphy, my RSO and I, stating we needed to come into mission planning around noon tomorrow to look at some maps for potential operations. John and I welcomed this opportunity, but it did not mean we would be deploying; that decision was yet to be made. I remember it was a great party, but with little more information than this being learned, John and I, together with our wives, left the party sometime after midnight.

I was planning on getting up normally for our Sunday routine. I would get the family breakfast and then we would all go off for the chapel service on base. Well, at 7:30am I get a call saying that I need to get John and head for the planning shop. I asked if it could wait until noon and the answer was a clear, 'It needs to be now'. I called John and picked him up about half an hour later and we headed down to the mission planning area. Now we got the Paul Harvey routine … the rest of the story. Problem in the Middle East – Yemen and Saudi Arabia are about to go to war over border disputes. Tanks have already started to assemble and information needs to be gathered as quickly as possible to give the president and the National Security Council, along with the State Department, an opportunity to defuse this building conflict.

John and I look the mission paths over, as the package calls for three missions flown into the Middle East at about two-three days apart from Mildenhall. Our routes to the Middle East from England are known. Once again the French are refusing to let the SR-71 fly across their country for quick access into the Mediterranean Sea and thereby reducing this five-refuelling, almost 10-hour mission by 2½ hours and a refuelling.

The major task of the morning is looking for suitable refuelling bases for our tankers. The special JP-7 fuel was stored at Mildenhall, Incirlik AB, Turkey and, I believe, at Moron AB near Seville, Spain. Turkey and Israel said the tankers would not be allowed to operate from their countries. Saudi Arabia was not chosen, but I do not remember why. Finally, Cairo West in Egypt was selected, and the tankers would have to pick up fuel from Turkey but not support us from there.

As one can imagine, the most critical aspect for timing was for the tanker operations to determine their best basing sites and then get the tankers, aircrews and maintenance support heading to these locations. The SR-71 might be able to fly at Mach 3+, but without the tankers, which took a while to get to their forward-deployed locations, the SR-71 was not mission capable.

At about 11:00am, John and I were told we'd be part of the advance party heading to Mildenhall to receive the SR-71 deploying from Beale, which was being flown by one of our most experienced and senior crews, Maj Rich Graham and Maj Don Emmons. [We were told] 'Oh, and by the way, you'll leave sometime this afternoon or early evening.' John and I called home and asked our wives to ready our bags. By about noon the ORI team had stopped all evaluations and was now just watching this magnificent reconnaissance team in action, doing what we were supposed to do for the United States. I kidded Gen Halloran that this is the 'best ORI scenario I have ever seen.' We both laughed, because this is what it is all about and why so many men and women have so dedicated their lives to serving their nation this way.

We got a quick trip home at around 1:00pm to pick up our bags and say goodbye. We did not know when we would be back. The families would be given that information as soon as it could be determined, but they weren't told where we were going nor anything about the missions that needed to be flown, as that was all classified. A quick stop by the squadron to pick up our checklists and various deployment materials: we had to secure a special UHF radio and other items to be used by the mobile crew to launch and recover the SR-71 from our deployment base at Mildenhall.

Early Sunday morning the tankers were already starting to depart before their final destinations were known. Since their missions involved multiple flight legs, time was the most critical factor in getting them forward and set up to operate. Operational locations, diplomatic clearances and operational concepts would be worked while the tankers were en route.

John and I were told we would be leaving around 4:00pm, with a refuelling stop at Pease AFB, New Hampshire and then on to Mildenhall, arriving an hour or so ahead of the deploying SR-71. It would be tight timing, but we needed to get the aircraft on the ground in England so that maintenance could turn it around once the tankers were forward and prepared to support, and an execution time was determined. Sensors would have to be prepped and uploaded – some of them needed almost a day to get them mission ready. Primary sensor for these missions would be the optical bar camera carried in the nose of the aircraft. We called it the countries camera, because it was an area camera that took a swath about 70 miles wide and thousands of miles long.

A last-minute delay meant that our tanker didn't depart Beale until nearly 6:00pm. Time would be really tight now. We flew to New Hampshire at the KC-135's top speed. A quick refuelling turn was a must at Pease, so the tanker aircrew called ahead and tried to have everything ready to go for our high-priority mission. Fortunately, it was September and the weather was at its best, an operation such as this in the dead

of winter would have added yet another dimension of time risk. But after landing, I remember the operation was a fine orchestration from this Northern Tier Strategic Air Command Base. Fuel trucks were standing by to refuel, with box lunches for the tanker aircrew and all of us passengers. John and I went into base operations and made a few essential telephone calls to update the overall mission status, determine a revised arrival time for the SR-71 into Mildenhall and receive any further instructions. We then rushed back to the tanker and shortly afterwards we were back in the air, heading across the North Atlantic to Mildenhall.

John and I had the tanker call Mildenhall about an hour before landing to reaffirm that the mobile car would be by planeside as the tanker's engines shut down. On landing, we had at most 30 minutes before the SR-71 touched down. We leapt into the car, hot wired the special radio into its electrical system, mounted its external antenna, and proceeded immediately towards the runway to complete our recovery checklists; this included gaining clearance from the tower to access the runway and carry out a visible inspection for any possible FOD [foreign object damage] items that could puncture the SR-71's tyres.

As we were checking the runway for screws, bolts, panels or whatever, John made contact with Rich and Don, affectionately known as 'Snake' and 'Nape'. They were about 10 minutes out and about to go over to approach control for recovery. We played about a minute of *Darl'n*, a David Allen Coe song that had almost become the theme song for the SR-71 programme at this point in time. It was late in the afternoon as '972, using the callsign Awry 26, touched down; I recall the weather was pretty good for England. Birdwatchers as usual were along the fence to film anything that might be flying on this Monday.

Tankers were still getting into position and the mission planning team with us worked into the night, planning the three-mission objective routes over the Arabian peninsula, focusing on the Saudi-Yemen border.

Refuelling tracks had now been established, with the first off Land's End, England, the second in the Mediterranean Sea, a third over the Red Sea going in and a fourth again over the Red Sea coming out; the final refuelling would be a long drag over the central Mediterranean, abeam Libya, to get us home. Because we were banned from flying over France, the last leg would be critical on fuel. Even with the priority handling British air traffic control provided us, fuel would be tight and English weather was always an additional risk.

By Tuesday afternoon the tankers were in place, and if the weather permitted we could launch the first mission early Wednesday morning. Early departure was required to place the SR-71 over the Arabian peninsula with optimum daylight for the cameras. Rich and I had already talked about who would fly which missions. I volunteered that I would not mind flying these longer missions, so the plan became that as they had brought the aircraft over, John and I would fly the first and third missions – up to 10 hours in length – and Rich and Don would fly the number two mission and then take the aircraft back to Beale … a four-hour flight.

As I remember, we met at about 3:00pm Tuesday afternoon and there were representatives from many organizations we did not normally see. This attested to the importance of the mission. We had attachés from our embassy, senior National Security Agency reps, the two-star USAF Director of Operations from SAC and many others. The USAF two-star had questions about our operations, was interested in the route we were about to fly, potential divert bases and the rules of engagement we were given to operate with.

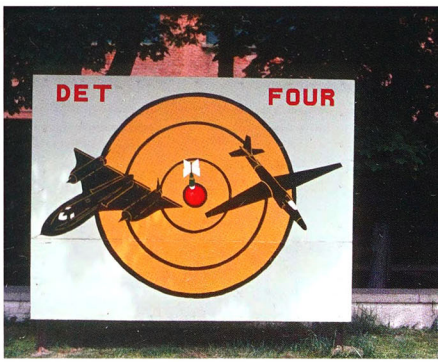
Humour entered at this point when asked if our families knew where we had left for. My answer was no, my wife Nancy knew it was an important mission and her parting comments to me were, 'Do good and I do not want to read about you in the paper or see you on the TV!' That was the nature of our business. Our families were truly most supportive.

The briefing went along fairly well until we got to the issue of possible divert bases if we had trouble. The State Department folks asked 'what do you mean trouble? Aren't you guys invulnerable?' Well, even the best of aircraft occasionally has a maintenance problem. Israel had denied us any overflight, and with Turkey's position of not wanting to support this operation from any of their bases, this left us with few options. John and I selected some bases we could use in the Mediterranean and in the objective area. We normally flew our missions radio silent, with a listening watch on HF radio for recalls or mission changes. Our tankers would include anything we wanted passed on as part of their end refuelling radio report. One of the great features of the SR-71 refuelling capability was the ability to talk with the tanker aircrew through the air-refuelling boom, thereby maintaining radio silence. For this mission we were told the president had requested through the National Security Council that the SR-71 report operationally normal at the end of each refuelling for immediate mission status verification.

Now started the process of going to bed around 6–7 o'clock to be rested before getting up at 1:00am in the morning for the physical, a breakfast of steak and eggs, mission briefing and then the suiting up process in order to be ready for about a 4:00am engine start. Wednesday morning we went through all the steps, including being installed in the aircraft. John and I were awaiting the thumbs up from Mobile (Rich and Don) to initiate our radio-silent engine start, taxi and take off. But at 4:00am word came through of a 24-hour delay because of weather in the objective area. We got out of the aircraft, talked with maintenance for a while and then tried to figure out what we were going to do until we went to bed around 6:00pm. Back at our room area we went and broke out some wine and vodka tonic drinks. The maids showed up at 7:00am and wondered what these crazy Americans were doing having a party so early!

And so off to bed we went on Wednesday night and got up again at 1:00am Thursday. Unfortunately, the same routine ended with the same results. At 4:00am, while strapped in the aircraft on a dark, wet taxiway, we got another 24-hour delay. It was okay for us, we could go back to our rooms, but for many of our tankers' aircrews, who had launched hours earlier to be in position, it was another long mission of burning down fuel until a safe landing weight was reached before they could land back at their respective deployment bases. Because of the restrictions imposed upon us, many of the tankers had to fly for a number of hours to be in the refuelling track to service us as we flew through. Wednesday had already found them burning down fuel and now the situation called for a repeat on Thursday.

That evening, I had an early seafood dinner at the Mildenhall Officers' club – unknown to me at the time, this would feature later in the story. Friday morning we were up at 1:00am and hoping that this would be the day we finally executed mission number one. The weather was okay in the



▼ On 31 March 1979, *Det 4* of the 9th SRW was established at Mildenhall. As its first unit badge clearly shows, at this early stage the det was a joint SR-71/TR-1 operation. (Bob Archer)

objective area but not really too good at Mildenhall, light rain and somewhat foggy. We were now at engine start and John and I have our fingers crossed. All of a sudden the crew chief and a Lockheed tech rep stormed up the ladder ... this was normally not good. I opened my helmet faceplate to determine the problem.

By way of a mission remembrance for our maintenance, Intel and photo people, they wanted me to fly two plastic bags full of SR-71 tie tacs. There was room in my lower suit leg pockets and I stuffed the bags in. I re-secured my faceplate and Mobile finally gave us a thumbs up. At last we were off on this adventure. Everything went as scheduled and we blasted off into the night at about 4:30am and headed across England at 25,000ft towards the southwest and our tankers near Land's End.

This was quite a change, as we normally headed east out over the North Sea and hooked up with our tankers fairly quickly. As we flew west I seemed to have more intestinal gas than normal. I figured it would pass as we climbed and the cabin pressure rose to 28,000ft. It was very common for us to work on relieving our gas build up as we climbed. It took almost 30 minutes before we were hooked up with the first of our tankers. By now I was feeling really uncomfortable. John and I discussed our options. We couldn't proceed if I was sick, but I sure didn't want the mission scrubbed and have it reported to the National Security Council that after two nights of mission slippage the mission was again postponed because the pilot was sick!

Well on the second tanker I had a quick complete diarrhoea attack (seafood special we figured), but afterwards I felt much better. Then came the next question: were there any adverse effects for 'sitting on this stuff' for the next 9 hours? John and I discussed this with the tanker crew and I felt that as I was now fine we could proceed.

We dropped off the tanker over the Atlantic Ocean and with a full load of fuel began our climb and acceleration while heading due south. The sun had come up and we arrived at altitude at 3.0 Mach and about 74,000ft. A turn east was executed, taking us through the straits of Gibraltar and into the Mediterranean. I now felt actually pretty good and we set up to initiate our descent and deceleration for our second refuelling. All was normal from these tankers that came out from Spain and they were extremely glad to see us for what was for them a third flying day. As directed, at the end of the aerial refuelling we called operationally normal and started our next accel and climb.

So far there had been no reactions from any potential hostile areas. Now departing the Mediterranean, the view of the great Pyramids and Sphinx was spectacular! Time to start down once more. John said we were not getting the normal ranging information from the tankers to adjust our rendezvous profile. Unbeknown to us, the tanker radios were not working, but they actually saw our contrails as we started down and experience guided them to set up their turns to roll out in front of us at the right spacing and speed. What can I say ... outstanding teamwork and a typical can-do attitude that makes it all happen.

The refuelling went without a hitch, but we were unaware that two Egyptian MiG-23s had followed our tankers out on this third day to see 'what was going on'. Unknown to us, a picture was taken of us refuelling from the other tanker from above, which months later John and I sign and which is then presented to the Egyptian Embassy and Egyptian Air Force to thank them for their great support. The picture was wonderful, showing three tankers in formation, us refuelling under the second tanker, and the pair of MiGs about 200–300 yards in trail.

With full tanks, we were now off for accel and climb number three, but this one would take us into our objective area. Defensive systems were again checked and all

other aircraft systems were functioning normally. Aircraft '972 was performing exceedingly well, but now as we passed through 45,000ft at 2.4 Mach we got a fighter attack radar indication coming from our right forward quadrant. We determined that a Middle Eastern fighter would not be a threat to us at this speed and altitude (after returning to California I talked with Kelly Johnson about this event, he'd been cleared into any of the missions and occurrences we might see or experience).

A turn to the left was initiated as we reached 3.0 Mach and were above 75,000ft. What a view ... sand for as far as one could see, with the occasional interspersed oasis. Incredible to think of this vast open desert, and they were fighting over this. There was a lot of sand blowing around below us, making for a hazy scene. Above, the sky was as black as ever. As we flew over the Yemen-Saudi border area, a left turn for a second loop in this objective area was coming up.

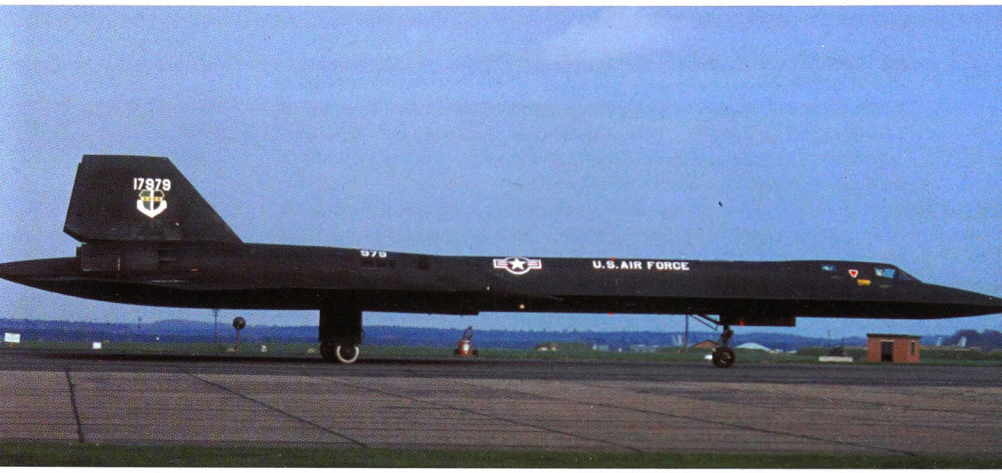
Hardly a word was spoken between John and I during these intense, high-activity time periods. Just as everything seemed to be working as planned, the aircraft tried to make a right instead of the planned left turn. I disconnected the autopilot and got us turning left. John was working to see if he could locate the source of the problem and checking the rest of the objective area to ensure we had maintained route integrity. We were on that mythical black line and swung through for another pass. Now as we left the objective area we were in a right descending, decelerating turn, looking for our fourth set of tankers. We were a little low on fuel because of the extra manoeuvring, but again the refuelling went without a hitch.

We were off the tankers again and climbing to start back to England. After this cruise leg we reached our last refuelling, number five, and then started the race home to return just under 10 hours of mission time. This last refuelling would be different from the rest, as a normal refuelling lasts about 15–20 minutes and transfers 80,000lb plus of fuel (12,000US gals): the goal is always to reach your end air refuelling point with full tanks to begin your accel.

Well, for this last refuelling, we would stay behind the tanker for 50 minutes, dragging along subsonically, to give us a closer end air refuelling point, assuring extra fuel to deal with potentially bad British weather. This refuelling was in the middle of the Mediterranean Sea, north of Libya. Everyone was monitoring closely to see if Libya detected and reacted to our presence. Descent and hook-up went flawlessly. I debated dropping off the tanker a couple of times and re-engaging to top off the fuel in the aircraft, but the decision was made that instead of risking not being able to hook up again, the easiest action was to stay on the second tanker's boom for about 45 minutes. We saw a lot of air traffic over the Med, but none of it was out of the ordinary.

John and I were ready for this last leg. We had been in our pressure suits now for over 9 hours, and I would later learn that with the normal dehydrating 100 per cent oxygen breathing environment, coupled with my earlier illness, I had lost over 8lb even though I had been eating tube food and drinking water throughout the mission. Climb and acceleration were normal and we passed back through the Straits of Gibraltar and started a turn to the north heading home.

Prior to descent we learned that the weather at Mildenhall had deteriorated and it was now raining. Descent took us down to enter the English landmass subsonically and now we once again drove across the country. With approach control, we set up for a precision approach, but while running the checklist we determined that the nose gear did not want to come down. We were now in the rain and had to run the alternate gear-lowering checklist, which involved leaving the landing gear selection handle



▲ The Warsaw Pact spring troop rotation of 1979 was monitored by '979. (Bob Archer)

down, pulling some circuit breakers and then manually pulling a release cable in the front cockpit. During the course of running these actions, we had terminated the precision approach and could now take over visually for another approach. After the longest time, the nose gear did fall free and into the down and locked position.

Today we had fooled the birdwatchers, as there were very few around the airfield on this rainy day. Landing, thankfully, was uneventful, and as we taxied into our parking position outside of the hangar it seemed that all the deployment personnel were standing around cheering our mission completion. John and I felt so honoured to be a part of this great team. Engine shutdown commenced and the gantry stand was rolled beside us. I felt pretty good but a little weak. I tried to tactfully tell the gang to not get too close and there was a pervading odour.

Unknown to John and I, the first tanker had relayed our problem back and during the flight the team had organized a little ceremony. At the foot of the ladder the 9th Vice Wing commander, Col Dave Young, met me to get a quick debrief, but more importantly to present me with an SR-71 tie tack they had painted brown and the accompanying certificate attesting that on this date I was the first 'surely not true but funny' supersonic turd. What can I say … laughter came from everywhere. I felt pretty good, so the physiological support guys gave me my customary after-flight refreshing beer – rehydrating was also a critical part of this high flight.

As it turned out, our mission would be the only one flown into the Middle East for this crisis. All the data required by the National Security Council had been collected, meeting presidential needs. On 12 March, John and I launched Snake and Nape into the air as Input 62, taking '972 home. Rich to this day kids me about tricking him into having the Chief of Standardization Aircrew act as a ferry crew for us. Such is the luck of life.

A SECOND DET IS FORMED

Surveillance of the spring 1979 troop rotation was conducted by Bill Groninger and Lee Shelton together with their respective RSOs, Chuck Sober and Barry MacKean. Aircraft '979

arrived at Mildenhall as Fern 29 on 17 April and departed on 2 May. In response to the CNO's requests for RADINT of the Barents Sea, the very first round-robin mission into the region was flown from Beale on 13 July 1979, in support of a SAC worldwide nuclear readiness exercise entitled Global Shield '79. The 10-hour 4-minute mission obtained high-resolution radar imagery of the targeted area, and two similar missions were conducted in 1980.

The autumn troop rotation of 1979 was covered from 18 October to 13 November by Rich Young/Russ Szczepanik and Joe Kinego/Bill Keller in aircraft '976. The same aircraft returned for the 1980 spring rotation on 9 April, and three Habu crews flew it during its 30-day deployment. Aircraft '972 arrived as Cup 10 and covered the autumn rotation between 13 September and 2 November, with four crews sharing the missions. However, due to work on Mildenhall's runway, the aircraft was positioned to RAF Lakenheath during the course of its deployment, from where it continued to operate until being flown back to Beale as Room 60.

On 12 December 1980, a third SR-71 deployment to Mildenhall occurred. This time the JCS had directed that the deployment should take place in response to a request from the Commander-in-Chief Atlantic (CINCATL), who was concerned at the possible intervention of Soviet military forces to quell rising dissent in Poland. Rich Young and Russ Szczepanik duly arrived in aircraft '964, having collected an HRR/ELINT take on their inbound leg to Mildenhall. This was to prove a milestone deployment, with the aircraft staying in the UK for four months; it was replaced the day before its return to Beale by '972 on 6 March, which in turn stayed for two months, eventually departing on 5 May 1981 as Yappy 22.

DIVERT TO BODØ

Not all SR-71 round-robin flights originating from Beale AFB to monitor the Soviet Northern Fleet on the Kola Peninsula were flown as planned, as B. C. Thomas now recalls.

My RSO, Jay Reid, and I were assigned this mission scheduled for Wednesday 12 August 1981 in SR-71 aircraft '964.

We reported for the flight at 7:00pm, checked weather and last-minute changes to the mission requirements, updated the intelligence briefing, met with the mobile crew and SR-71 crew chief, ate a meal of steak and eggs, donned our space suits, conducted an aircraft pre-flight, and were ready for a 9:47pm take-off. The flight profile called for a 45,000lb take-off fuel load; a rendezvous with two tankers over Idaho to fill our tanks; acceleration to Mach 3+ while cruise-climbing to 80,000ft; descending to 26,000ft to meet more tankers over Goose Bay, Labrador; crossing the Atlantic Ocean just south of Greenland and Iceland at Mach 3 to a third refuelling over the North Sea, northeast of Scotland.

The next acceleration was to Mach 3.25 to penetrate the Soviet air defence region around Murmansk. Passing west of Norway, then north of Finland, we headed toward the Soviet coast by flying inbound from a point in the Barents Sea and approaching the land mass at Murmansk directly at 90° head-on.

There is no doubt that our presence was heralded to Soviet personnel on the ground by the sweet (and rather loud) sound of freedom: the distinctive triple-sonic boom of the 2,200mph SR-71. That knowledge would always give us a certain inward sense of pride; not in ourselves altogether, but pride in the aircraft, the engineers and designers who built her, the maintenance people who made her safe to fly, and the

▲ Majors BC Thomas and Jay Reid became the first crew to land an SR-71 at a continental European air base, when they diverted into Bodø, Norway on 12 August 1981. (BC Thomas)

faithful tanker crews who were always there when we needed fuel. All of these support personnel were vital for any successful mission.

The Soviet Union claimed their sovereign territory extended 100nm from their landmass. The international norm is 12 miles. Heading inbound, we turned so that we flew within 12.5 miles of the Soviet coast in a 30° right-banked turn while obtaining radar imagery (or photographs) and recording Soviet electronic countermeasures. This somewhat provocative technique was 'trolling' – we stimulated the Soviet defences, causing their radios and radar to bristle with electronic information, thus impelling them to reveal telltale electromagnetic signatures indicating the type of equipment, modes of operation, and limits. There were sometimes other American assets offshore, but within radio range, which also collected electronic transmissions.

After departing the take area, the plan was to refuel again over the North Sea, accelerate to Mach 3, refuel for a fifth time over Goose Bay, then fly Mach 3 thereafter to Beale AFB. We planned to land at 8:15am on 13 August, after 10.5 hours of very intense flying.

We were operating a long distance from home base, the mission was deemed vital, and no crewmember ever wanted to abort a flight. Any mission deviation could easily lead to an international incident, would be scrutinized by the highest National Command Authority, and possibly result in our names appearing in every major newspaper in the world. We certainly felt this responsibility, but had the utmost faith in our preparation, training and the talent and dedication of all our support branches.

After transiting Murmansk and while hooked up with the tankers during the fourth refuelling, I saw a flicker of the master warning light. Jay Reid announced the light at the same time that I saw it in my peripheral vision. I disconnected from the tanker's boom and manoeuvred back to the pre-contact position. Our indication was the illumination of the left engine oil supply low-quantity red warning light. From our training and experience with the aircraft emergency checklists, we knew immediately that this required that we 'land as soon as possible'. The mandate to land immediately was borne out of long experience with malfunctions, the type that would crash the airplane if another single system failed.

The natural tendency for military aircrews is to complete the mission if humanly possible. To counter this inclination, the wing commander had designated certain emergencies sufficiently critical to require immediate landing. This was one of those emergencies.

Our mission planning and alternate airfield study had prepared us to know quickly where to fly if an emergency required immediate landing. Some military intelligence might limit our choice of a suitable landing field, depending on the political situation, and of course weather was always a major consideration. Jay and I quickly agreed that recovery at the joint civilian/military air base at Bodø, located on the Norwegian coast a few miles above the Arctic Circle, was best. We were about 60 miles away.

We wasted no time notifying the tanker crews of our decision to land. They set up a holding pattern in international airspace to assist in refuelling, or to be our radio relay if necessary. Their standing orders were to await our call to release them, presumably after our safe landing.

While Jay was transmitting our mandatory abort reports via high frequency, long-range radio, I contacted Norwegian Approach Control. Our orders were not to

broadcast that we were flying an SR-71, but rather give the general type as 'US Air Force Tactical', which really meant nothing to a controller concerned about arranging for emergency equipment and notifying proper authorities of our emergency condition.

My call sign was 'Belmont 86' and my transmissions to approach control were something like this:

'Bodø Approach, Belmont 86, six-zero miles west, declaring an in-flight emergency, request straight-in approach to land on runway zero seven.'

'Belmont 86, say aircraft type, nature of emergency, souls on board, and fuel remaining.'

'Bodø Approach, Belmont 86, US Air Force Tactical, engine problem, two souls, zero plus four-five fuel on board.'

'Belmont 86, say again aircraft type.'

'Bodø Approach, Belmont 86, US Air Force Tactical.'

'Belmont 86, I do not understand your aircraft type.'

'This is Belmont 86, we will land in approximately 10 minutes and I will deploy three drag parachutes: two small and one 40ft chute. I will jettison all three on the runway. I don't have time now to talk.'

We were cleared to land with nothing more said. We touched down at Bodø on August 13, 1981 at 1:12pm (Norwegian time) after a total flight of 6.4 hours. When we were on short-final approach, tower controllers had no problem identifying our aircraft type, and immediately sent out notifications, which, we learned later, included the local press.

What could we expect? What kind of reception would the Norwegians give us and would the airplane be secure, especially considering that we had on board highly classified images and electronic recordings from Murmansk?

I asked for and was given taxi directions to the Norwegian military ramp, where I could see some friendly looking F-104s, the frontline NATO fighter aircraft. After I shut down the engines and we opened our canopies, the first person to greet us was a Norwegian military pilot who said: 'Welcome, do you know Bill Groninger?' Bill Groninger was a fellow SR-71 pilot who was a USAF instructor pilot before he was chosen for the SR-71 programme. The Norwegian pilot was his student. We learned that many Norwegian fighter pilots received their initial training in the USA. We definitely were among friends!

We were quickly introduced to General Olav Aamoth, the wing commander at Bodø. He asked for any special requirements and I requested full-time guards be placed on the aircraft, with only myself and Jay Reid authorized to admit personnel to the plane. He agreed and assured us that the aircraft would be guarded continuously. I then asked for a secure phone to call the command post at Beale AFB.

General Aamoth drove us to an underground labyrinth of tunnels carved into the side of a mountain, containing maintenance shops and aircraft. He directed me to a telephone within his command centre. I called the 9th SRW commander, told him the time of the abort and that operations were normal up to the emergency, thus relaying that we had the reconnaissance data on board. This information was needed to arrange for the proper retrieval of the mission materials. We briefly discussed the nature of the emergency, and I assured him that the aircraft was safe. He said that we were to stay there until the aircraft was repaired, which would probably take three days. The 9th SRW had already started a recall for the support personnel necessary for the recovery of the SR-71.

▶ After diverting into Bodø, '964 was christened 'THE BODONIAN EXPRESS' – note tail fin. (Paul F. Crickmore)

General Aamoth seemed unusually concerned, as he insisted that a Norwegian officer physically be present with us until we left. He introduced us to an F-104 pilot, 1Lt Roar Strand, who would help us with anything we might require. He was a very pleasant guy and I kind of felt sorry for him because I was sure he had better things to do than to 'mind' us for three or four days.

Roar Strand was very accommodating. After all the immediate activities associated with bedding down the aircraft were accomplished, he took Jay and me to his apartment, where we met his beautiful girlfriend, then to a restaurant in downtown Bodø, where we spent a pleasant evening.

Roar accompanied us to the transient quarters to sleep in the same room with Jay and me. Early the next morning, he went with us to a military dining hall for breakfast. It was there that I got my first real surprise of the trip: the only food presented was about four types of fish soup, all of which, to this unaccustomed American, smelled terrible, especially so early in the morning. I asked if any cold cereal was available, and thankfully, there was. Cornflakes. Espresso coffee completed the fare.

General Aamoth joined us and with him was the American air attaché to Norway, who had just flown in from Oslo specifically to see us. I knew then that this visit was attracting more attention than any of us needed or wanted. He asked about the emergency, the condition of the airplane, and wanted to know if anything unusual or unpleasant had happened to us. I assured him that we were fine and that recoveries such as this one were well planned and the maintenance team would probably be here that day or the next. We did not anticipate any logistical problem as this type of activity was performed often, usually without help from other local organizations, and the Norwegians were taking extra care to assure that we were not contacted or hindered.

The rest of the day was devoted to making preparations for the maintenance recovery team from Beale AFB. General Aamoth, to my surprise, stated specifically that he did not want any talk or outward expression of anything clandestine (not that we would anyway). More than once, he made the explicit statement that when we landed, he considered us to be a NATO-allied aircraft in distress and that military courtesy and professional consideration meant that we were to be afforded the support necessary to see us on our way and that he did not want any mention of reconnaissance activity or publicity.

It was way too late for the admonition concerning publicity, however.

Virtually every newspaper in Norway had news of a 'spy plane' landing at Bodø splashed across its front page. Newspapers in the USA also had the story. The reports generally said that it was the highest-flying and fastest airplane in the world, and opined on what type of 'spying' we were doing. Jay and I did not like the publicity, but were relieved that no newspapers published our pictures or names. None of us flying reconnaissance missions wanted to be publicly identified while we were engaged in these activities. Our missions were highly classified, and no good could ever come from talking to reporters about anything associated with our reconnaissance flights.

The next day, 15 August, a KC-135Q from Beale AFB arrived carrying our special fuel for the SR-71, the deployment commander, Lt Col Randy Hertzog, who was also the commander of the 1st Strategic Reconnaissance Squadron (1SRS); and the maintenance crew plus civilian technical representatives from Lockheed.

The recovery plan written by the 9th SRW stated that in foreign stations, the recovery team would all wear civilian clothes so as not to disclose who was military. This did not sit well with General Aamoth! He told me to tell Col Hertzog to have all

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military personnel wear military uniforms. I did not know why he would issue such an order, but I complied. The military team dutifully returned to the KC-135 and changed into uniforms.

Over the next two days, the maintenance team ran into several problems repairing the aircraft. We had parts flown in from various sources. A spare engine start cart, a machine containing two Buick Wildcat engines in tandem and specifically designed to mechanically rotate the SR-71 engines for starting, was flown in by C-130. On the third day, our aircraft was repaired and made ready for take-off.

Since preparing the SR-71 for a supersonic (Mach 3) flight would have taken more equipment and time, we elected to fly subsonic directly to RAF Mildenhall, England, from which the SR-71 had conducted operations previously. We would fly in formation with the KC-135Q, which had landed at Bodø for our support two days earlier.

The maintenance crew performed outstandingly and we were ready to depart on Sunday 16 August. Pre-flight preparations for Jay and me were smooth, except that our first engine start attempt failed. The start cart could not, observing normal rpm and torque limits, achieve the required aircraft engine speed for a safe start. On the second attempt, the crew chief, Clarence 'Skip' Hosler, valiantly ignored the cart rpm/torque limits and informed me on interphone that this would be the last attempt. He later told me that the connecting rod glowed red-hot just before the aircraft engine reached the start rpm.

We took off at 1:42pm. It was the roughest take-off I ever made in an SR-71. The runway was smooth to sight, but owing to the very long, slender and flexible forebody of the SR-71 (where the nose wheel is located) and the distance from the nose wheels to the main landing gear (42ft), the slight undulating wavelike runway set up a vertical motion in the cockpit which amplified as we accelerated for take-off. It was getting so bad by the time we achieved rotation speed (180kt) that I was very concerned that something might break before lift-off (210kt). The acceleration of the SR-71 was quick and I was able to raise the nose before the up-and-down oscillation became traumatic. With the gear up, everything returned to normal. We rendezvoused with our tanker for a planned refuelling to augment our take-off fuel, and landed at 2:53pm local time in England, for a flight of 2.2 hours.

With a million members of the Polish Solidarity movement having gone on strike on 7 August, and mounting tension between communist state officials and the rest of the Polish population, Strategic Air Command directed that upon arrival, we would set up a deployment base at RAF Mildenhall and conduct several additional operational missions before returning home. Jerry Glasser and Mac Hornbaker were sent from Beale AFB to meet us when we arrived from Norway and they flew an operational mission a few days later. We were ordered to stay at RAF Mildenhall until relieved, so Jay and I also flew another operational mission after Jerry and Mac. When Rich Young and Ed Bethart arrived as our replacements, we departed for Beale AFB on 2 September ['964 finally left Mildenhall and returned to Beale on 6 November].

What started out for us as a 10.5-hour, round-robin mission, California to the Soviet Union and back, turned into a 21-day marathon of SR-71 missions, involving six SR-71 aircrew members, a host of maintenance and support personnel, and a true adventure for us all.

Along the way, we made some very special friends.

POST SCRIPTS:

1. After I retired from the US Air Force and our SR-71 reconnaissance activities were no longer classified, I contacted General Aamoth. He had also retired from the military after being chief of staff for the Norwegian Air Force from 1985 through 1991.

I asked him about his reluctance to have our military personnel wear civilian clothes and why he admonished us not to do or say anything that would identify our mission as being reconnaissance. He told me a very interesting story: On 1 May 1960, General Aamoth was a fighter pilot (lieutenant) in the Norwegian Air Force stationed at Bodø. That was the day that Francis Gary Powers was shot down flying a CIA U-2 aircraft over the Soviet Union. Although Powers had taken off from Pakistan, his intended landing base was Bodø, the same Norwegian base at which I landed. Furthermore, the (then) commander of Bodø knew about the U-2 and that it was to land at his home base; however, neither the Norwegian prime minister nor the chief of the Norwegian Air Force knew anything about it. To make matters much worse, the Soviet premier, Nikita Khrushchev, threatened to 'nuke Bodø' for 'cooperating' with the United States in the 'U-2 Affair'. After an investigation, the military commander was summarily fired.

General Aamoth saw a very stark parallel to that story when we landed. He told me that he was sitting in his office when we were on final approach. The airfield tower controller telephoned and told him to look out his window to see what aircraft was landing at his field asking to be parked on his military airport apron.

I now understand General Aamoth's concern!

TThe political situation in Poland continued to deteriorate as the clamour for reforms and democracy gathered momentum. By early December the situation had reached breaking point. Late on the night of 12 December 1981, the communist leader, Gen Jaruzelski, cut all communication links with the West and deployed troops and armour to set up road blocks and occupy strategic installations. He then declared a state of marshal law and appeared on television to announce the formation of a military Council of National Salvation. He claimed that strikes, protest demonstrations and crime had brought the country 'to the border of mental endurance … the verge of an abyss'.

Two days later it became apparent that at least 14,000 trade union activists had been rounded up and arrested; seven had been shot in the Selesian coal fields while resisting marshal law. Would Jaruzelski turn to the Soviet Union for help in his struggle to retain control of Poland? Or would President Leonid Brezhnev commit Soviet troops to crush the uprising as he had done in Czechoslovakia on 21 August 1968? Clearly, the Reagan administration needed some answers, and fast, and as ever Det 4 crews were on hand to provide them.

Majors Gil Bertelson and Frank Stampf were on the roster for this important sortie. The significance of their mission dictated that it was to be backed up

▼ 61-7971 arrived at Mildenhall on 23 December 1982, and with '972 having already flown in just five days earlier, it meant that for the first time Det 4 had two SR-71s under its command. (Lindsay Peacock)

▲ 61-7971 first deployed to Det 4 between April and 13 December 1982. It was forced to divert into Bodø just a week after its arrival in the UK and spent three days at the Norwegian base between 7 and 9 May. (Lindsay Peacock)

with a spare aircraft; Majs Nevin Cunningham and Geno Quist (known within the crew force as 'Neno' and 'Geno') were suited up as spares. As Gil and Frank disappeared in their SR-71 into the cold, wet night, Nevin and Geno waited at the end of the runway in '958 for the code words that would either send them back to the barn or on their way on a long mission over much of the North Atlantic and northern Europe.

Soon after, Frank called back to Geno on their discrete HF radio frequency, saying simply, 'You guys have got it'. To which both spare crewmen simultaneously said 'Oh shit,' and off they went. The weather in the first air refuelling area over Nevada and Utah was so bad that it was all the Habu crew could do to find the tanker in the thick clouds. When they finally located it, and were on the boom, it proved extremely difficult for Nevin to maintain the connection due to the heavy turbulence. The updrafts bounced the KC-135 all over the sky, to the degree that its autopilot was unable to react fast enough to the unstable conditions. This refuelling was therefore one of the most difficult experienced by both the tanker and SR-71 crews. Nevin asked the tanker pilot to forget autopilot and 'go manual' to achieve a better offload platform. Meanwhile, the transfer operation was enshrouded in Saint Elmo's fire, which lit up both aircraft like glowing Christmas trees.

After finally completing the ragged refuelling operation, Nevin lit both burners and pressed on to the second ARCP over maritime Canada. Again the weather did its utmost to make the operation as uncomfortable as possible. After quickly crossing the Atlantic, they headed towards their third refuelling track off the west coast of Norway. Here they were sandwiched between layers of cloud, but the air was smooth in the Arctic twilight and the top off went smoothly. The long Atlantic crossing required a split off-load from two tankers. After taking half of his load from one KC-135, Nevin looked for the other tanker. As he closed in on the second aircraft, he discovered he was joining up with a Soviet Ilyushin Il-20 "Coot" ELINT aircraft! Nevin flew '958 up to the would-be tanker, its crew no doubt equally startled by the presence of a mysterious Habu.

Nevin and Geno quickly dropped back to find the second tanker, and after they topped off, the pilot lit the burners for the next high-hot run. At 72,000ft they headed into the take area, where it was especially dark at altitude (it seemed that the only source of light was from the two J58 afterburners 100ft behind them). Having completed an inner loop around the Baltic Sea, they were on their way back down to the fourth refuelling when the sun popped back up over the horizon.

To further complicate matters on this long and difficult mission, Geno was unable to make radio contact with the tankers. Fortunately, Nevin spotted contrails well below and ahead of them, and simply followed the aerial 'railroad tracks' for a join-up. While on the boom, Geno broke further bad news to Nevin about their astro-inertial navigation system,

which had failed. Clearly it would not be possible to return to Beale, since ANS failure was a mandatory abort item. They therefore settled into formation with the tankers, which led them to Mildenhall, where snow and ice covered the runway and taxiways. Finally, after what had turned out to be a very entertaining mission, '958 slithered to a halt outside the dedicated SR-71 barn, and Nevin and Geno climbed out after their 8½-hour sortie – their 27th together.

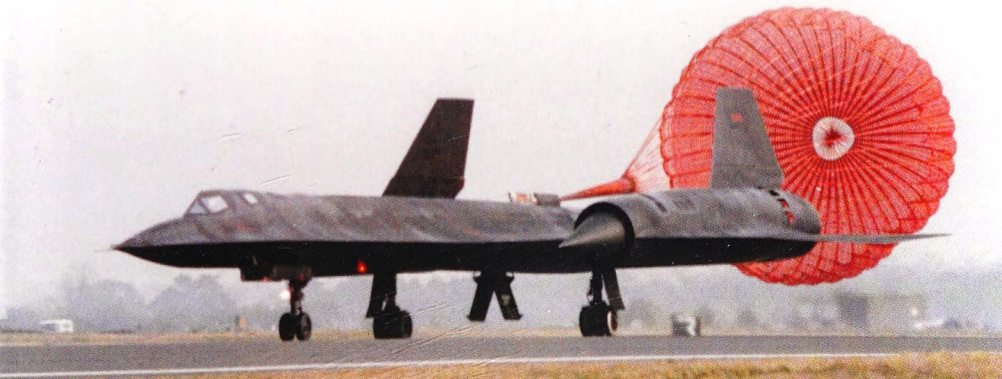
Back at Beale AFB, the Californian weather was less severe. As BC Thomas and Jay Reid climbed from the tandem cockpits of a T-38 on completion of a routine training flight on Wednesday, 16 December, they were met by Col Randy Hertzog, the wing DCO. He instructed them to go home and grab whatever they needed for an indefinite deployment to RAF Mildenhall. The KC-135 carrying both them and a maintenance team departed Beale at 19:30 and arrived in England at 07:30 the next morning.

Nevin and Geno flew aircraft '958 on a second sortie around the Baltic on 18 December, and another mission was planned for BC and Jay as soon as they were crew-rested from their transatlantic ride. An analysis of Geno's take had revealed that the Soviet Union was not making preparations to intervene militarily to quell Poland's political unrest.

On Monday, 21 December 1981, BC and Jay departed Mildenhall in '958 and headed out over the North Sea for the first of five air refuellings. Their flight was tasked to monitor the Soviet-Polish border situation from a stand-off position in international airspace over the Baltic Sea, and to include a long northern run around the coast of Norway along Russia's north coast. Jay activated the sensors as they cruised at Mach 3 on their northern loop, which exited the take area near Murmansk on a westerly heading toward the fourth refuelling. Out over the North Atlantic, the right generator cut off, but BC managed to get it reset.

After the fifth tank near Goose Bay, Labrador, another problem arose that would limit their cruise speed inbound to Beale. During acceleration BC noted that '958's supply of liquid nitrogen had been depleted, and that the fuel tanks could not be pressurized to inert the fuel fumes at high Mach. He limited the cruise Mach to 2.6 in accordance with emergency operating procedures and made his final descent into Beale somewhat low on fuel after a flight of almost 10 hours. The series of Baltic sorties not only obtained invaluable intelligence at a time of high international tension, but also vividly demonstrated US resolve to stay actively engaged in the situation by using its key surveillance assets in the NATO-Warsaw Pact theatre of operations.

Det 4's capability was doubled during the closing stages of 1982 when two SR-71s were based 'permanently' at Mildenhall for the first time, the aircraft being manned by a number of crews on 30-day deployments and flying a succession of 'routine but highly productive missions' across the North Sea and Eastern Europe. After '972 had been deployed for seven months, it was ready to be returned to Beale for periodic heavy maintenance, which included replacing fuel tank sealant.



▼ 61-7972 deployed to the UK on no fewer than six occasions between September 1974 and July 1983. It is seen here sporting low-visibility markings during its final deployment to Det 4, which ran from 18 December 1982 through to 6 July 1983. (Paul F. Crickmore)

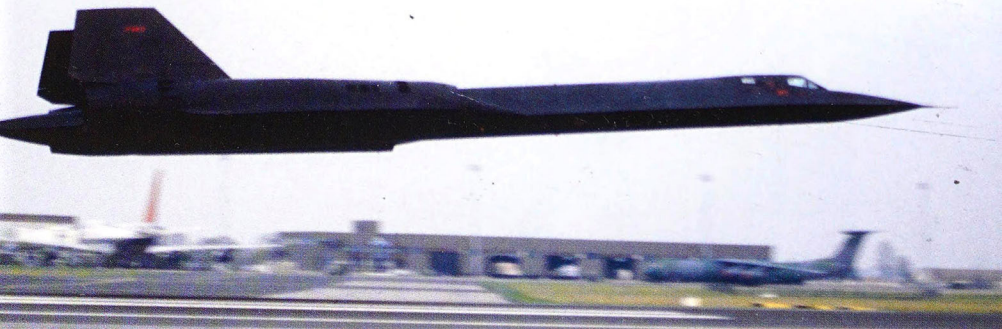
Nevin and Geno got the big redeployment sortie and left Mildenhall at 1000 hours on Tuesday 5 July 1983 via the Barents/Baltic Seas, and returned across the North Atlantic to California. After completing their first take run on a northern loop over the Barents Sea, they decelerated into the Viking North air-refuelling track in international airspace west of Bodø, Norway. Topped off, they climbed back to altitude and entered their second collection area, within the narrow Baltic corridor, to complete the reconnaissance portion of the mission. Preparing to head home, they again decelerated and descended into the Viking North area over the North Sea. Back at high altitude, Geno calculated that Nevin would have to accelerate to maximum Mach to improve the aircraft's range to ensure they would have enough fuel to reach the next set of tankers near Labrador.

During this high-hot phase of the flight, the left engine's EGT became uncontrollable, with indications that '972 should not be flown faster than 3.05 Mach to ensure engine damage would not occur. By flying at this less than optimum speed, the SR-71 would not be able to reach the KC-135s. Taking manual control of the inlet spikes and doors would have made matters worse since it lacked the precision of DAFICS and they would only be able to maintain Mach 3 in that configuration. Another alternative, slowing to subsonic speeds would exacerbate their low fuel predicament even further and they also found they could not get back to Bodø. Therefore, they had to press on toward their tankers in the hope that they might be able to improve their fuel flow rate or to divert into Iceland. For the next 45 minutes Nevin flew at 3.09 Mach before slowing to 3.05 to allow the EGT to drop back into the 'green'.

As they approached the 'point of no return' off Iceland, Geno recalculated the fuel situation, which had improved slightly. Nevin decided to press on and told Geno to get the tankers to fly towards them to further shorten their distance to hook up. After completing their hook-up in record-breaking time (to their great relief), the fuel streamed into '972 at more than 6,000lb per minute. Back at Beale after another seven hours of SR-71 excitement, neither crewmember would admit to how much (or how little) fuel they had remaining before they made contact with their everlasting friends in the tanker.

AIRCRAFT NUMBER '955

In May 1983, it was decided by HQ SAC and Air Force Systems Command officials to demonstrate Loral's Advanced Synthetic Aperture Radar System (ASARS) on an SR-71, before upgrading the rest of the Habu fleet with this new high-definition ground-mapping radar system. After aircraft number '955 was equipped with the new system, BC Thomas and John Morgan were assigned the task of conducting the first operational test flight.



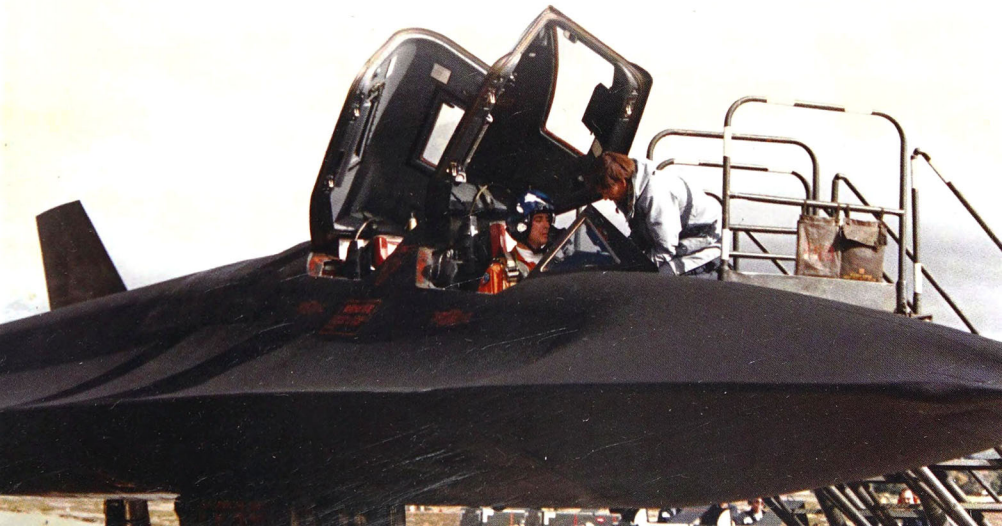
Truly 55, aircraft '960 flown by Maj Jim Jiggens and Maj Ted Ross, makes a slightly lower than usual go-around, having returned from an operational mission. Jiggens was a member of the Thunderbirds aerobatic display team prior to joining the Senior Crown programme. (Paul F. Crickmore)

On 1 July 1983, they made SAC's first ASARS familiarization flight, which lasted just over 5 hours, during which John learned ASARS 'switchology' and operating techniques. Five days later Maury Rosenberg and Ed McKim also flew the modified SR-71 on a 5-hour sortie, recovering into Beale AFB rather that Palmdale. On 9 July, Maury and Ed deployed '955 on a 7-hour flight to Mildenhall, via the Barents/Baltic collection area.

British plane spotters, peering through binoculars and telescopes from various off-base vantage points, excitedly recorded the Habus' arrival, some noting the slightly bumpy ASARS nose, but a familiar tail number. On that occasion, all of them logged a false serial, since a cover number was being used to conceal the fact that the 'test bird' was overseas. As '955 was already known by military aviation enthusiasts as 'the Palmdale test-ship', it had been decided by the maintenance folks back at Beale to temporarily rechristen '955 as '962 for this deployment. The latter jet had visited Mildenhall earlier, and would not draw unwelcome attention and speculation to the unique test deployment.

Nine days later, on 18 July 1983, BC and John took the aircraft on a 2.6-hour ASARS operational test sortie to monitor military installations in East Germany. On 21 July, Maury and Ed took their turn on a 4-hour mission. The next day BC and John flew '980 to the International Air Tattoo at Greenham Common, to help raise money for the RAF's Benevolent Fund. Among the many thousands of people who came to see the aircraft were some of the 'Greenham Women', who had long been demonstrating against many political issues, and who had been camping outside the base to gain public recognition. The day before the SR-71 was due to return to Mildenhall, some of the demonstrators managed to daub white paint on the Habu. They were quickly arrested for causing a disturbance and for possible damage to the aircraft's titanium, which later laboratory analysis proved was unharmed.

Several days later, Maj Jim Jiggens and Capt Joe McCue performed an unforgettable departure from the base. After a morning take-off on 26 July for the short flight back to Mildenhall, Jim (an ex-Thunderbirds airshow demonstration pilot, who had obtained prior permission from the base commander to do a farewell flyby) flew a wide circular pattern at 250kt towards the Greenham Peace Camp. As '980 reached a strategic point, Jim pushed both throttles to full afterburner, whereupon the SR-71 thundered over the encampment at a very low altitude. Applying sharp back pressure to the control stick and lofting the Habu into a



Major BC Thomas carries out post-flight checks at Palmdale on '955. Note the aircraft's bulbous nose section, designed specifically to house the ASARS high-resolution ground-mapping radar. (Lockheed Martin via BC Thomas)

spectacular climb, Jim allowed his sleek aircraft to trumpet the 'sound of freedom' as only an SR-71 could.

The final ASARS demonstration flight was conducted on 30 July when BC and John flew '955 on a 7.3-hour flight back to Beale via the Baltic and Barents Sea. The series of tests was extremely successful, proving that ASARS represented a quantum leap in radar resolution and capability for reconnaissance purposes. Captains Gary Luloff and Bob Coats ferried the aircraft from Beale back to Palmdale on 2 August, where further tests were conducted prior to an initial order for two production radar sets for the operational fleet. ASARS imagery was a technological break-through, reducing resolution down from about 6ft at nadir to 1ft. This generated a commensurate increase in requests for SR-71 operational missions to support the intelligence needs of the USAF, US Army and especially the US Navy.

PERMANENT DEPLOYMENT

Although the 1983 deployment to Mildenhall was still called a 'temporary operation', two SR-71s remained at the base for almost the entire year (apart from a period lasting 33 days early on, and three days in the autumn). As early as 1980, SAC had begun planning changes in the SR-71's European operations to cut the cost of deployments and increase the frequency of surveillance flights. Such changes required actions of 'air diplomacy' on the part of HQ 3rd Air Force, and USAF and SAC staff specialists. On instructions from the JCS, HQ USAF and HQ SAC, Col Don Walbrecht of the Third Air Force (accompanied by Lt Col John Fuller and Lt Col Dwight Kealoa of HQ USAF/XOXX and Lt Col Kenneth Hagemann of HQ SAC/XP) proposed to Assistant Secretary Martin Scicluna, and to Gp Capt Frank Appleyard, Deputy Director of Operations in the RAF's Directorate of Organization (DGO/RAF), that SR-71 operations at Mildenhall should be bedded down on a more permanent basis.

Scicluna (head of the MoD's 5-9 (AIR)) led the British contingent that reviewed the proposal. Although he thought that the SR-71's high visibility image might cause 'political difficulties' at some senior levels, he took the issue forward to Secretary of State for Defence Sir Francis Pym, who agreed to consider it. After specialized briefings to a few MoD insiders, which included certain intelligence officers who had special access to US reconnaissance information, recommendations were taken to Pym, who agreed to the initiative. Another meeting held three days later worked out the politics of the proposal.

▼ Major Tom Danielson and his RSO Lt Col Stan Gudmundson launch 61-7973, callsign Yale 16, into all-too familiar UK winter fog. Weather conditions faced by crews during a TDY deployment at Det 4 were guaranteed to vary considerably from those experienced back at Beale. (Paul F. Crickmore)

The following week, each member of the US team briefed his respective CINC or Deputy Chief of Staff at Ramstein, Omaha or Washington, that the programme was on-track in Whitehall. Soon after, Prime Minister Thatcher's approval was noted as a simple 'change of mode of operations' from temporary deployments to a permanent presence at RAF Mildenhall. U-2 operations were to be moved from Mildenhall to Alconbury as both bases were beefed up for their expanded intelligence roles.

During the next two months, Walbrecht made regular trips to London to answer questions from MoD officials who prepared

authority documents for ministerial signature. Scicluna later confided that the SR-71 initiative went down very well because of long-standing intelligence sharing connections, and because one of his junior staff officials had suggested calling the proposal a simple 'change of mode' of current operations from intermittent to permanent basing. The permissive loop was then closed, and the SR-71s could come to England, where they would remain the plane spotters' favourite attraction for many years.

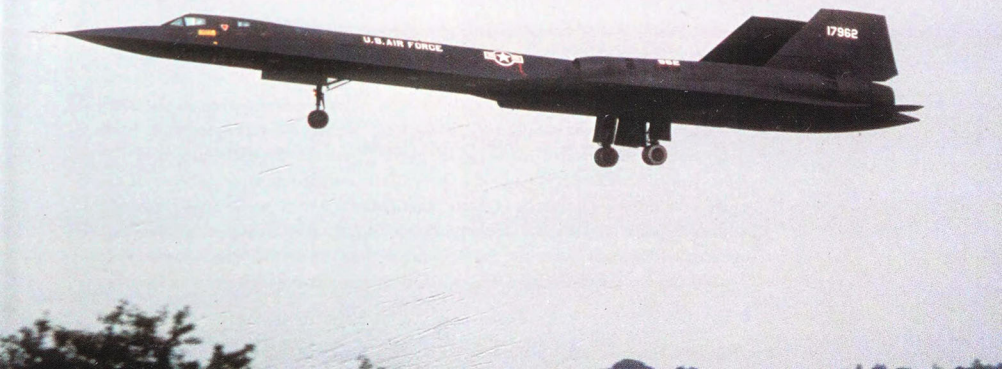
On 5 April 1984, Prime Minister Thatcher announced that a detachment of SR-71 aircraft had formed at the Suffolk base. A blanked clearance to operate two Habus from the United Kingdom had been granted by the government, but certain sorties would still require prior high-level approval from the MoD. Moreover, those especially sensitive operations would require a clearance from the PM herself.

Anglo-American co-operation extended into SR-71 missions themselves; Habu sorties venturing into the Barents and the Baltic areas were sometimes being coordinated with the RAF's small fleet of Nimrod R.1 ELINT aircraft, operated at that time from RAF Wyton in Cambridgeshire by No 51 Sqn. Such co-operation also extended to the Luftwaffe, which used Atlantics in a similar role to the Nimrods. During such sorties, the SR-71 took on the role of provocateur, with timings controlled to within seconds to ensure that the slower ELINT platform was in the optimum position to take full advantage of signals that weren't usually forthcoming from the Soviet side.

FIGHTERS

Immediately after World War II, it was clear that two geopolitical systems would dominate the world. Inherent in both was their mutually abiding mistrust of one another, which sowed the seeds for an arms race that would continue until one system achieved dominance over the other. The emergence of the Convair B-58 Hustler, the Lockheed A-12 and SR-71, and potentially the North American B-70 Valkyrie and Lockheed B-12, inevitably provoked the self perpetuating 'cause and effect response' within the opposing power blocs when, as early as 1960, the Mikoyan-Gurevich Opytno-Konstruktorskoye Byuro (OKB; design bureau) was tasked to develop a supersonic interceptor, capable of defeating these new and emerging threats.

The result was the development of the first 'big MiG' – the spectacular MiG-25. Officially entering service following a directive dated 13 April 1972, the first *Protivovozdushnaya Oborona Strany* (PVO; Anti-Air Defence Troops) MiG-25P units were stationed near Moscow,



▼ Don't believe all you read ... Captured on finals, '61-7962', flown by Majs Maury Rosenberg and Ed McKim, prepares to land at Mildenhall on 9 July 1983, having flown in from Beale via the Barents/Baltic Seas collection areas. In fact, the aircraft displays a false serial applied to 61-9755 for a classified ASARS operational evaluation. (Bob Archer)

▲ Lt Col Nevin Cunningham (left, Det 4 commander) and 1st SRS commander Lt Col Joe Kinego catch up on the latest developments at the UK detachment. Both had extensive experience flying the SR-71 within European airspace. (Paul F. Crickmore)

Kiev, Perm, Baku, Rostov and in the North and Far East. By the mid-1970s, the MiG-25P constituted the backbone of the Soviet Air Force's interceptor inventory, and soon after converting to type, PVO units stationed near Soviet border areas were carrying out intercepts on SR-71s involved in peripheral reconnaissance missions of the Soviet Union.

On 6 September 1976, Lt Victor Belenko, the pilot of a PVO unit based at Chuguyevka, located to the north of Vladivostok, defected to the West via Japan in 'his' MiG-25P, providing the US intelligence community with a windfall. The aircraft was dismantled by US Air Force intelligence staff, and although later returned to its country of origin, it was obvious to Soviet officials that the aircraft's capabilities were now severely compromised and unless the design was drastically upgraded, the type's combat efficiency would be enormously degraded.

In a joint effort that involved the Ministry of Aircraft Industry and military experts, the Mikoyan-Gurevich OKB embarked upon a comprehensive upgrade programme. The earlier monopulse low-pulse repetition frequency Smerch-A2 (Izdelye 720M) radar was replaced by the much-improved Sapfeer-25. This new radar unit was lager than its predecessor and required a modest fuselage stretch forward of the cockpit; its improved capabilities enabled detection of targets with an RCS of 16m2 at a range of more than 100km (62.5 miles).

An infra-red search and track (IRST) system was developed which, when coupled with the radar, made the weapons system less susceptible to the effects of ECM; it also provided the platform with the ability to perform 'sneak attacks' without switching on the radar. The upgrade also included installation of the BAN-75 target indication and guidance system that acted in concert with the ground-based Luch-1 guidance system to align the optical axis of the aircraft's radar with the target; this also ensured that its radar was less sensitive to jamming. In addition, a new IFF set and ground-based command system were provided (the latter replaced the Vozdookh-1M and incorporated a jam-proof aircraft receiver).

Four R-60 missiles would be carried instead of four R-40TDs, which, due to more effective homing heads, almost doubled the range of the earlier weapons. Finally, and perhaps not surprisingly, the upgraded platform would be powered by newer engines, two R-15BD-300s. Work progressed rapidly on the design, designated MiG-25PD or Izdelye 84D (D for Dorabotannyy, meaning modified or upgraded), and by the end of 1982, the entire fleet had also undergone a mid-life update programme, leading to the designation MiG-25PDS (Perekhvatchik, Doralotannyy v Stroyou; field-modified interceptor).

There now follows an insight into MiG-25PD operations as conducted by the 787th Istrebitelniy Aviatisonniy Polk (IAP; fighter aviation regiment) against Det 4 SR-71s flying over the Baltic Sea. It is reproduced by courtesy of Lutz Freund, editor of *Sowjetische Fliegerkrafte Deutschland* 1945–1994.

Around 1980, the Warsaw Pact's air defence forces (PVO) introduced a new alarm call – 'Jastreb' (hawk). It meant that a Lockheed SR-71 Blackbird was approaching. Later on it became the standard alarm signal for all high and very fast-flying targets.

Under normal circumstances the alarm call came several minutes before an SR-71, typically flying at an altitude of 20 to 25km at some 800–900m/s, entered the range of Soviet and German Democratic Republic (GDR) air surveillance and guidance radars. At Finow air base the alarm resulted in the 787th IAP scrambling a MiG-25PD fighter. They took off and approached the intruder in a wide curve on a parallel

▲ MiG-25PDs of the 787th IAP conducted practice intercepts against Det 4 SR-71s operating over the Baltic Sea. (Yefim Gordon)

course, with a separation of a few kilometres. During this MiG-25 manoeuvre the aircraft overflew all of the GDR's northern or southern area. On military maps the MiG-25's flightpath was shown as a large circle.

Depending on the weather, SR-71s flew reconnaissance missions once or twice a week along the Warsaw Pact border. During military manoeuvres flight frequency could rise to two missions every 24 hours. The aircraft used two standard routes. The approach towards GDR airspace was from Denmark. Over the West German city of Kiel the flight path continued either to Aufklärungsstrecke 2 (reconnaissance route 2), along the Baltic Sea coast line to Leningrad (now St Petersburg) and back, or to Aufklärungsstrecke 5, along the GDR's western border. Such missions normally lasted around 60 minutes. The distance to the border varied due to the aircraft's high velocity and it was unable to follow the border's exact line. Sometimes an SR-71 came within a few kilometres of GDR's border in the area of Boizenburg, or just slipped over it.

Had there ever been an order to shoot down the intruder, the MiG-25 crews were ready. But the routine of this event never escalated to such a dramatic situation. After a short time flying alongside the SR-71, the MiG-25PD headed home. The usual flightpast home to Finow was over Poland.

Beside the airborne defenders, the missile defence forces were also on alert. It would have been possible to successfully destroy the intruder, but for a successful lock-on and shootdown they would need a slightly lateral shot to reduce the extreme altitude. The missile defence forces remained on alert as long as the SR-71 was detected in the region by Soviet radio listening troops.

Finow-Eberswalde was built in 1936 and used by Soviet forces from 1945. With the introduction of MiG-25PU its runway (10/28) was lengthened to 2,510m. Between 14 July 1982 and 10 August 1989, the 787th IAP operated MiG-25PD from the base, more or less coincident with the period of SR-71 operations out of Mildenhall, UK. After the withdrawal of the SR-71 from the UK, MiG-23s and MiG-29s replaced the MiG-25.

The SR-71's awesome performance capabilities also provided a unique opportunity for allied fighter controllers and fighter pilots to evaluate various intercept solutions against a high-speed, high-altitude threat, as Rolf Jonsson, a retired Swedish Air Force fighter controller, now recalls:

The most spectacular alerts in the Swedish Air Force during the eighties occurred about once a week, when the Blackbird was operating in the Baltic. These were also probably the most frustrating events of the entire Cold War, with our fighters trying to reach the same altitude and position as this high-speed, high-altitude target, efforts which, if successful, would allow the fortunate pilot to catch a brief glimpse of the fantastic SR-71 at quite close quarters.

When the SR-71 first began operating in Europe our air force was equipped with the Saab J 35F Draken and although intercept attempts were made, the aircraft's performance wasn't up to the task. However, one point was clear – the method that offered the greatest opportunity of success was a frontal attack, with both aircraft exactly on a 180° divergent heading – always assuming of course that the SR-71 didn't turn! Other very important factors to try to determine when planning an intercept were the high altitude air temperature and the SR-71's altitude.

When the Saab JA 37 Viggen entered service, suddenly the mix was right; the aircraft's performance and avionics capabilities combined with the eagerness of its pilots and a high degree of teamwork with the air command and control centres, including the radar tracker (a conscript), the intercept controller and the pilots.

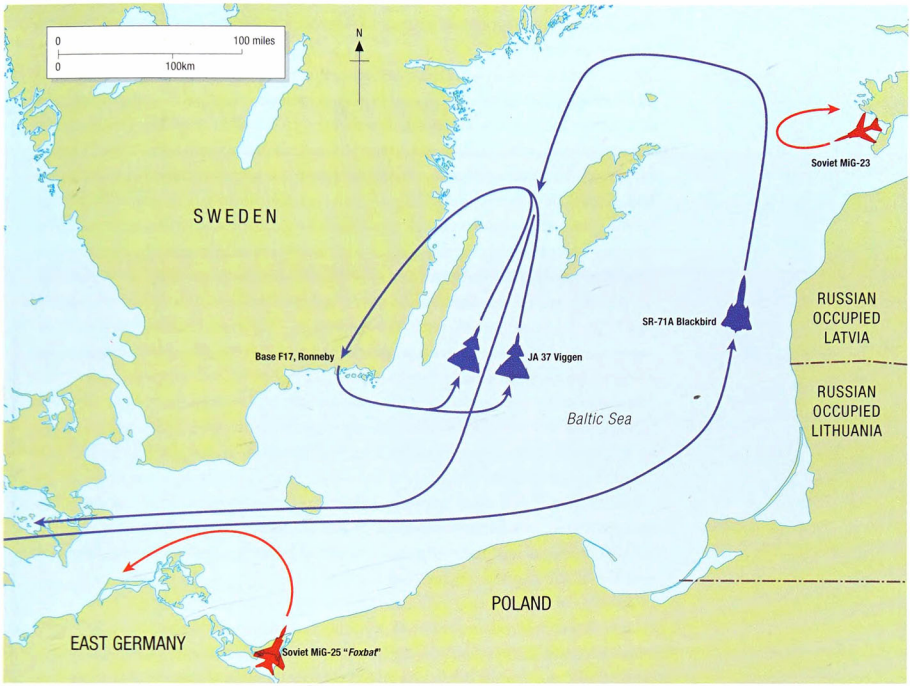
For everything to work, the pilot needed to reach the speed and altitude that corresponded with information derived from the data tracker system in the Air Operations Centre (AOC). This data determined exactly where and when the pilot needed to initiate a pull-up from cruising altitude to acquire a radar contact. If the pilot failed to lock his radar on first time that was it, the opportunity was gone – at least for another week. On some occasions our pilots had problems locking-on because the SR-71 crew activated their defensive countermeasure systems, but pilots soon learned how to avoid triggering such systems. Also, an electronic counter-countermeasures system was built into the JA 37.

Another high performance aircraft operating from bases around the Baltic was the Mikoyan-Gurevich MiG-25 "Foxbat"; this had a speed advantage on the JA 37 Viggen, but the latter had a superior weapon system and, from 1981, was already using an information dissemination system similar to the Joint Tactical Information Distribution System the US later deployed on tactical aircraft including the F-15C Eagle.

The most difficult phase of the intercept for pilots was during the steep climb, since they had to monitor their engine instruments to ensure they remained within the Volvo Flygmotor RM8B turbofan's EGT limits, and also scan their radar screens. During this phase the pilot tilted his radar scan angle down, to its maximum of -15°. The radar then had just a few seconds to locate and then lock on to the target before the two aircraft passed one another with a combined closing speed of Mach 5; it was an extremely impressive spectacle to watch on radar from the ground!

The intercept window was incredibly tight, and all the SR-71 pilot needed to do during the fighter's final climb phase was manoeuvre just slightly and the intercept solution changed and failed. One of the main problems facing our Viggen pilots was that one of the rules in their Orders for Safe Flight stipulated that flight above 16,000m was prohibited without the use of a full pressure suit and these weren't available, so our pilots needed to be careful or they could be grounded by their divisional commanders.

The SR-71 'Baltic Express' flights were usually known about an hour before the aircraft entered the area. The Habu always entered the Baltic Sea over a reporting point named 'Codan', located about 80km south of Copenhagen and on a heading of about 090°. This usually triggered a scramble by a pair of JA 37s that were kept on



▲ This map shows the SR-71's standard route around the Baltic Sea, with the typical 'engagement' zones of the Soviet Air Force MiG-25s and Swedish Air Force JA 37 Viggens against it.

alert at either F10 Ängelholm, F17 Ronneby or F13 Norrkšping, although sometimes even temporary bases like Visby were used. The best base for an SR-71A intercept, however, was F17 Ronneby, because this was best positioned for the acceleration and climb phase, about 30–50km southeast of Gotland and Öland.

The SR-71's Baltic flight path remained the same throughout the time it operated in Europe and consisted of a single anticlockwise loop that took about 30 minutes to complete. It remained in international airspace and first flew off the Polish coast, then just before the Bay of Gdánsk, well inside the Kaliningrad enclave, the aircraft turned left, onto a heading of about 015°. With the Habu now flying at 70–80,000ft only the Sukhoi Su-15 "Flagons" based at Vainode, in Latvia, had a chance of making an intercept, and it's doubtful that any of them were actually successful. Certainly the MiG-21 "Fishbeds" and MiG-23 "Floggers" based at Pamu, Haapsalu and Tapa in Estonia had no chance; their trails on our radar screens in Sweden were so harmless it was painful!

The Habu then proceeded to a point about 60km west of the Estonian island of Saaremaa, where it began a long, programmed left turn, taking it onto a southerly heading of about 190°, rolling out east of Stockholm. It then passed between the islands of Gotland and Öland, and this always impressed us because the corridor of international airspace between the two islands is only two miles wide; the Habu only violated our airspace once (this was the only time that it became necessary for the Swedish foreign department to protest about an airspace violation) when an SR-71

was forced to interrupt its high speed left turn, reduce speed and descend from its position in the north of its route due to an inflight emergency. [On that occasion, the SR-71 was forced to fly directly over Gotland – at this point AJ 37 Viggen pilots took hand-held photos of the Habu and it is clear to see from these that the aircraft was flying on one engine]. It was in this area that our JA 37 pilots carried out their practice intercepts. Once 56–74 km southeast of Gotland and Öland, the 'Baltic Express' turned onto a heading of about 265° and exited the area over the same point that it had entered.

Almost every time the SR-71 was about to leave the Baltic, a lone MiG-25PD "Foxbat-E" belonging to the 787th IAP at Finow-Eberswalde in the German Democratic Republic was scrambled. The 787th maintained three squadrons (around 40 aircraft), which may have flown only the MiG-25PD, but probably consisted of two MiG-23M "Flogger-B" units and one of MiG-25PDs. A detachment of the latter was also maintained at Wittstock. Another detachment might have been based in another southern airfield in East Germany. Arriving at its exit point, the 'Baltic Express' was flying at about 72,000ft and the lone MiG would reach about 63,000ft in a left turn before rolling out and always completing its stern attack 1.6nm behind its target. We were always impressed by this precision; it was always 63,000ft and 1.6nm behind the SR-71.

When the SR-71 detachment at Mildenhall was deactivated, the 787th IAP re-equipped with new Mikoyan MiG-29 "Fulcrum-Cs", but even after the withdrawal, we believe that at least three "Foxbats" remained behind at Finow-Eberswalde, just in case the 'Baltic Express' returned!

It is interesting to note, when reading Rolf Jonsson's account involving a lone MiG-25PD out of Finow-Eberswalde, that the simulated attack consistently terminated when the interceptor was at 63,000ft and 1.6nm behind its target; this would seem to suggest that these were the parameters necessary for its weapons system to effect a successful intercept if the order to fire was ever given. This is interesting, since US Air Force intelligence specialists (and SR-71 crewmembers) believed that the only possibility of an interceptor successfully engaging an SR-71 would be head-on (or beak-to-beak), a position given further credence by the fact that the DEF system designed to tackle an airborne threat operating within the X-band (DEF A2) was forward-facing.

The key to the JA 37's success was the integration of a highly sophisticated datalink, which, until relatively recently, remained highly classified. The Swedish air force gained significant expertise in the datalink field with a system installed in the J 35F back in 1965. However, the system installed in the JA 37 Jaktviggen (or fighter Viggen) was far more capable than that of its predecessor; it entered service in 1982.

It had the ability to upload and download data to four active aircraft on the same link; it also had the capability of downlinking data from an airborne JA 37 to others still on the ground. Datalink information was displayed on the horizontal situation display (HSD) and a tactical display, the latter using link symbology that could be overlaid with an electronic map on a multifunction display (MFD). As an integral part of the Stri-60 command-and-control system that was built around it, the JA 37 could take off, attack, land, refuel and rearm, then re-engage, with little or no voice communication, while enduring heavy jamming.

The first successful intercept of an SR-71 over the Baltic was carried out by Per-Olof Eldh, who recalls the incident:

In 1980, I joined the 2nd Squadron 'Blue Marlins' of Fighter Wing 13, equipped with

the JA 37 fighter Viggen and based at Bravalla, just outside the town of Norrkšping, on the Baltic coast. Our mission was to conduct operational tasks and evaluations focused on air defence and air superiority. We were already equipped with a datalink from the air defence network; the next step was to establish it between fighters and we achieved this in 1981. Integrating this with the PS-46 air-to-air pulse-Doppler radar and the Sky Flash missile provided the JA 37 with a significantly enhanced capability.

Looking at the map display on the MFD, the pilot could see other friendlies, the enemy, SAM sites, etc, and this information was constantly updated via the datalink by fighter controllers and other JA 37s, giving the pilot unprecedented levels of situational awareness. In fact, the system was so good that we could employ the same tactics – line abreast, box formations or scissors manoeuvres – day or night in VFR or IFR [visual flight rules or instrument flight rules] conditions.

When I conducted the first Swedish Air Force intercept of an SR-71, the target had completed its north-bound pass off the Soviet coastline, and had turned west, south of the Finnish island of Aland, and was tracking south on a heading that would take it between Gotland and Öland. The datalink from the fighter controller was on, and I lined up for a head-on attack with a target angle of 180°. From my altitude of 8,000m I accelerated to Mach 1.35 then pulled up, very gently, continuing to accelerate to between Mach 1.7 and Mach 2.0, topping out at between 18,500 and 20,000m. All the target data was on my map display, including radar detection of the target at maximum range, which then locked on immediately afterwards. I simulated missile launches – the closing velocity was very high, between Mach 4.5 and 5.0; the SR-71 was flying at Mach 2.98 and 21,500m. I had visual contact.

In total I have five hot intercepts against the SR-71 to my credit. All can be described as successful. I was visual three times; on a couple of occasions the SR-71 was contrailing, which was very useful because you could do a visual check to ensure you ended up in the right spot!

When we began conducting these SR-71 intercepts, the squadron began a special air safety programme and we all underwent an intense series of emergency procedure checks in the simulator, because we were flying at the outer edges of the envelope and at higher risk.

On 9 January 1986, while leading a JA 37 three-ship in aircraft tail number '38', we received target data immediately after take-off from Bravalla. We flew in trail, receiving updated target information over the link from both the fighter controller and the other fighters in the formation. All three of us carried out successful intercepts between 13:14 hours and 13:25 hours, about 50km west of the town of Visby, on the island of Gotland. Major Moller was number two, in tail number '60', and Captain Ulf Johansson number three in tail number '53'.

I remember that the SR-71 was flying at an altitude of 22,000m and a speed of Mach 2.9. Ulf had some difficulties coming back to earth – he actually reached the target's altitude and passed the SR-71 head-on at the same altitude with some side separation, but suffered a high temperature engine stall! A cartoon drawn by SAS Captain Stefan Lofren to commemorate this event was used as a poster in our briefing room.

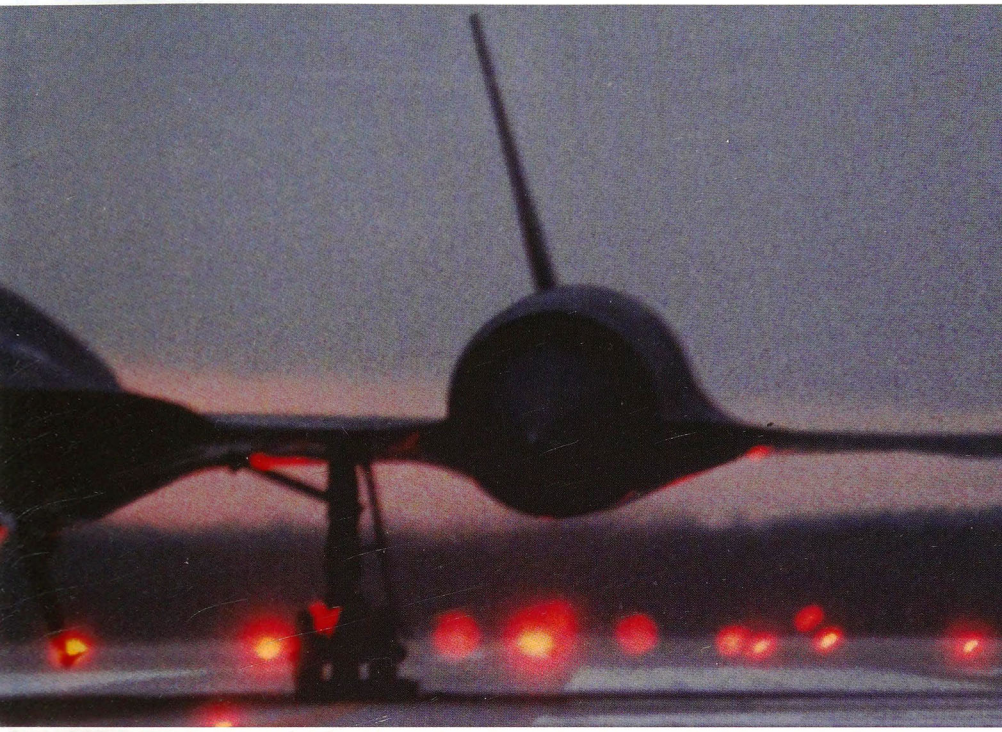
It's apparent that intercepting a Habu was an extremely difficult undertaking, and that's with the aircraft adhering rigidly to pre-agreed PARPRO tracks. In times of war, the SR-71's route would have been far more varied, making the calculation of a successful intercept solution more complex and therefore even less likely.

▲ Having completed their EGT checks, and with wheel chocks still in place, the crew of 61-7964 holds on runway 29 in readiness for a dawn departure. (Paul F. Crickmore)

At 1010 hours on 3 June 1986, Majs Stormy Boudreaux and Ted Ross left Mildenhall in '980, heading out across the North Sea toward their first refuelling west of Norway, on another Barents/Baltic sortie. At 26,000ft in the refuelling track, they found the sun directly ahead of them and clouds all around as they closed for contact with the KC-135s in diffuse and strangely angled sunlight, which reflected brightly off the undersides of the tankers.

As soon as the boomer made contact, Stormy found himself flying formation in almost blinding conditions, with the SR-71's cockpit instruments obscured (in the dark shadow of the dashboard below the windscreen), forcing him to arrange his tiltable car-like sun visor to shield against the high contrast conditions. That effort proved of little value, for while in the contact position on the boom, the tanker's reference points for formation flying were flashing in such extreme contrast that they appeared to be surrounded by 'sea or sky or whatever'. A strong sensation of vertigo overtook Stormy, leaving him with a false sense of diving and climbing (and with the even more powerful sensation of flying inverted while refuelling). An interphone call to Ted assured Stormy that he was not upside down; he was then able to continue filling '980's tanks while fighting his sense of flying 'straight up or straight down'.

After clearing the tanker, and his senses, Stormy climbed through 60,000ft, where he noted through his periscope that '980 was still pulling contrails, which should have stopped above that altitude. Another check at 70,000ft revealed that he was 'still conning', which he hoped would surely stop before they approached their target area. Upon entering the Barents Sea zone, the aircraft began a programmed left turn to the north east and then reversed in a large sweeping right turn to roll out on a westerly heading, which would take it on the collection run and back across



the entry point. Established on the westerly heading north of Archangel, the crew noted that they were still 'conning', which was most abnormal at high altitudes. To add to their dismay, Stormy spotted three other contrails ahead of them and to the left, but turning to converge in what might be an intercept. Another southerly glance revealed more 'cons' closing from the left but at a lower altitude.

These six Soviet fighters, each separated by approximately 15 miles, were executing what appeared to be a well-rehearsed turning intercept manoeuvre to pop up somewhere in the vicinity of the fast-moving Habu and fire off some sophisticated air-to-air missiles. The Soviet fighter pilots had executed an in-place turn, which would have put them in a perfect position for a head-on attack had '980's track penetrated Soviet airspace. As Ted monitored the fighters' electronic activities, Stormy increased speed and altitude.

Suddenly a contrail shot by just beneath the nose of '980, leaving both crewmembers waiting for a missile or another aircraft to appear that might have 'spoiled their whole day'. It was with great relief that Stormy realized they were now paralleling their inbound contrail, and the contrail they had just crossed was their own, laid when they turned north east before heading west. For a few moments their hearts missed several beats at the thought of having unwanted high-Mach company 15 miles above the cold Arctic seas.

Stormy eased off some power and settled back into their routine of high-Mach cruise. The autopilot completed a long 'lazy turn' around the north shore of Norway before Stormy started his descent towards another refueling. To complete the mission, the crew made an easy high-altitude dash into the Baltic corridor and down through West Germany before heading home to Mildenhall.

LEBANON

By the mid-1970s, the complicated politics that had bonded Christian and Muslim factions together in relative peace in the Lebanon since it declared independence in November 1943, had broken down. Soon after, a long and tragic civil war erupted, fought by multiple groups and complicated by the wider implications of the region's power politics. In an effort to restore peace, President Assad of Syria dispatched more than 40,000 of his best troops, a force which managed only to engage in a series of fruitless battles. Assad's forces were backed by Palestine Liberation Organization (PLO) fanatics, which stiffened the resolve of the various Muslim militia groups in the area. In August 1982, the grim catalogue of human carnage had reached many thousand dead on all sides of the rising conflict.

Some 15 terrorist organizations sympathetic to the Palestinian cause operated from numerous bases in southern Lebanon, and periodically launched attacks against neighbouring Israel. These acts of terrorism became progressively more numerous and violent. After several retaliatory strikes, Israel responded on 6 June 1982 with a major land, sea and air invasion aimed at destroying the PLO leadership and its armed forces.

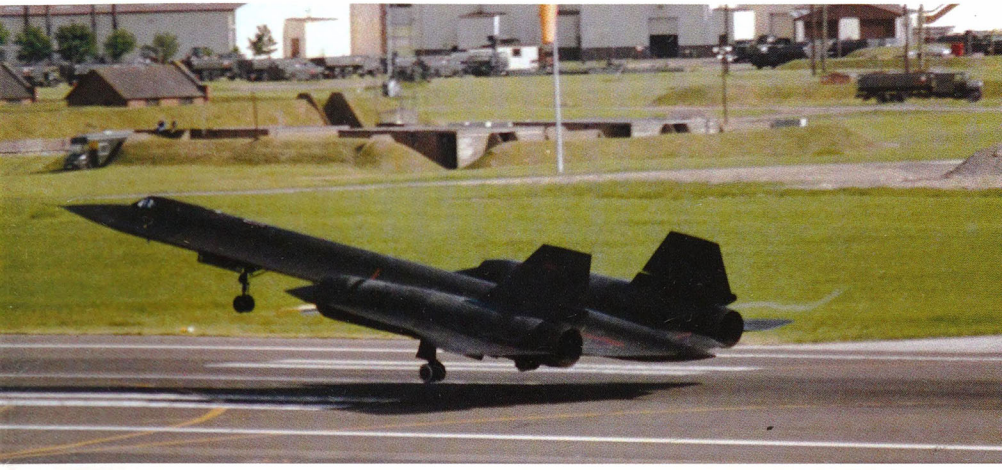
Twenty-three days later, Israeli troops were at the gates of Beirut in a position to fulfill their stated objective, but Prime Minister Mechachem Begin was forced to modify his fierce demands in the face of threats of Soviet intervention to aid Syria and US disapproval of his invasion. The Israeli siege of Beirut culminated in 7,000 PLO fighters abandoning the city and fleeing the Lebanon into sympathetic Arab sanctuaries in Syria, Jordan, the Sudan, North and South Yemen, Algeria, Iraq and Tunisia, where their leader, Yasser Arafat, set up his headquarters.

On 28 September President Reagan announced that the US Marines were to resume their peacekeeping role in Beirut, which had been interrupted by the Israeli invasion. Reagan said he believed it was important that the US maintain a military presence in the area until the Lebanese government was in full control. France, Italy and the United Kingdom also dispatched troops to the region in attempts to add world pressure to the policing of the area, for the departure of the PLO heralded the beginning of a new era of terrorism in the Lebanon.

On 18 April 1983, a suicidal member of Islamic Jihad, a pro-Iranian network of fanatical Shi'ites, drove a truck loaded with 300lb of explosives up to the entrance of the US Embassy in Beirut; he detonated it, killing 40 people, including eight Americans. Two more of these kamikaze-type raids followed on 23 October, killing 241 US Marines and 58 French paratroopers. Another, on 4 November, claimed the lives of 39 Israeli troops within their guarded camp. By early 1984, the peacekeeping position had become untenable and the troops were withdrawn, leaving behind only the Syrians and the Israelis. By February, the Lebanon was once again embroiled in an ever-worsening civil war.

The resurgence of Islamic fundamentalism had been sparked off by the Ayatollah Khomeini on 1 April 1979, when he declared Iran to be an Islamic republic. Khomeini was a zealot whose unquestioned devotion to Islam was only equalled by his all-consuming hatred for the West and, in particular, the United States. According to most Western intelligence sources, Islamic fundamentalism would represent the most destabilizing influence in the Middle East throughout the 1980s.

Once again, the capabilities of the SR-71 would be called upon in this hot spot, to serve the needs of the transatlantic intelligence community, and of those friendly nations who shared in the revelations of the Habu's high-quality photographic and electronic surveillance. Missions over the Lebanon were therefore flown by Mildenhall Det 4 crews to keep tabs on the Syrian and Israeli armies, as well as on various contraband movements that supplied Islamic Jihad warriors and other supporting groups.



▲ 61-7975 only deployed to Det 4 once, between mid-July and 16 October 1984. (Paul F. Crickmore)

One such Middle Eastern SR-71 sortie took place on 27 July 1984. At 0730 hours Stormy Boudreaux and Ted Ross departed Mildenhall in '979, using the call sign Boyce 64. This important flight (the crew's 30th together) was complicated by several factors: the usual refusal of overflight transit across France, which necessitated entering the Mediterranean area via the Straits of Gibraltar; inlet control problems during acceleration to high Mach, which forced Stormy to 'go manual' on bypass door operations; and spike control problems at 2.2 Mach, which further aggravated control.

By this time '979 was eastbound and nearing Mach 2.5, and the flightpath was committed to entering the Med on the preplanned heading, or overflying West Africa or Spain during an abort. Consequently, Stormy elected to 'go manual' on both inlet spike and door operations. Emergency operating procedures dictated that an aircraft in a 'double-manual' configuration should not be flown above Mach 3 and 70,000ft. Therefore, Stormy held '979 at that degraded limit and pressed on through the Straits of Gibraltar, high over the Mediterranean. Off the southern coast of Italy they decelerated and descended for a second refuelling. Standard procedures (once returning to subsonic flight) included resetting all inlet switches back to 'automatic' and to continue the next leg of the flight in 'auto', since such inlet glitches often cleared on another acceleration cycle.

Stormy and Ted followed this logical procedure, but '979 repeated the previous disturbances. At that point 'according to the book', they should have aborted the flight. The mission had been planned around a single high-speed, high-altitude pass over the target area. The well seasoned crew reasoned they had already come so far that they could make that one pass easily and collect the needed reconnaissance data within imposed operating constraints, especially since they could easily break off over the waters of the Eastern Mediterranean should they have any serious difficulties over land.

They completed the recce run manually, but found that '979 (in the less fuel-efficient manual inlet configuration) ended the run in a notably depleted fuel state. Ted urgently contacted the tankers, which were orbiting near the island of Crete, and asked that they head east to meet the thirsty Habu. As the SR-71 descended, Stormy caught sight of the tankers some 30,000ft below, and executed what he described loosely as 'an extremely large variation of a barrel-roll' and slid in behind them 'in no time flat'. The boomer plugged in immediately and '979 began taking on the much-needed JP-7. Hooking up well east of the normal ARCP,

▲ When Det 4 became solely a 9th SRW SR-71 detachment, the change was reflected in this redesigned insignia. (Paul F. Crickmore)

Boyce 64 had to stay with the tankers much longer than the normal 12 to 15 minutes of 'on the boom time' to drop off at the scheduled end-AR point before proceeding back to England.

With '979's tanks filled to a pressure disconnect, Stormy and Ted climbed to high altitude on the final leg back through the Straits of Gibraltar and home to Mildenhall, where they landed after almost seven hours, four of which had been spent at supersonic speed while carefully controlling inlet spikes and doors manually. The good news was that their take was of exceptional quality as a result of a cold front that covered the eastern Mediterranean and produced very clear air for razor sharp photographic imagery. Det 4's commander, Col Jay Murphy, was especially proud of his crew's very notable mission accomplishments, but the bad news was that they had flown a degraded aircraft within range of a known Soviet SA-5 SAM site. Overweighing that concern, however, was word from Washington that the take was 'most valuable' for the analysts back at the National Photographic Interpretation Center.

LIBYA

A group of revolutionary army officers seized power on 1 September 1969 while King Idris of Libya was on holiday in Turkey. In a revolt led by a subaltern named Muammar Gaddafi, the officers proclaimed Libya to be a republic in the name of 'freedom, socialism and unity'. Washington recognized the new regime just five days later, allowing Gaddafi to consolidate his position of power over the next 2½ years, during which time he nationalized foreign banking and petroleum interests within Libya and was called a 'strongman' by western news editors.

Gaddafi made his interpretation of 'freedom, socialism and unity' clear to the world on 11 June 1972 when he announced he was giving aid to the Irish Republican Army. Such support was extended to similar terrorist organizations within Europe and the Middle East.

In the summer of 1981, Gaddafi decided to lay claim to territorial rights over much of the Gulf of Sidra, on Libya's northern shore. The United States refused to recognize any extension beyond the traditional 3-mile limit, and to back up the 'international waters' claim to the Gulf, USS *Nimitz* (CVN 68), attached to the Sixth Fleet, began an exercise within the disputed area on 18 August.

Interference from Libyan Mirages, Su-22s, MiG-23s and -25s culminated in the shooting down of two Su-22 "Fitter-Js" by F-14 Tomcats from VF-41 'Black Aces'. Libyan-American relations plunged to an all-time low as Gaddafi's aggression continued. Northern Chad was annexed by Libyan forces, an English policewoman was shot dead by a Libyan 'diplomat' in London, arms were sent to Nicaraguan Sandinistas and continued support was given to terrorist organizations throughout the world.

US patience was running out. In an address to the American Bar Association on 8 July 1985, President Reagan branded Libya, Iran, North Korea, Cuba and Nicaragua as members of a 'confederation of terrorist states'. Libya's political ruse finally reached its end after further actions in the Gulf of Sidra, the hijacking of a TWA Boeing 727 airliner on a flight from Rome to Athens and the bombing of the La Belle discotheque in Berlin.

THE PLANNING BEGINS

Frank Stampf recalls the planning process prior to committing the SR-71 to Libyan skies.

The week before Christmas 1985 for those of us assigned to SAC HQ in Omaha, Nebraska was pretty much the same as many other past holiday seasons. Plenty of parties and social get togethers, and lots of opportunities for frustrated aviators now stuck in headquarters staff jobs to swap war stories about the 'good old days'. The pace of work activity had slowed down a bit, although not very much. Those of us at the Strategic Reconnaissance Center within HQ SAC were still kept fairly busy planning, tasking and coordinating real-world reconnaissance sorties being flown by U-2, TR-1, various models of RC-135, and SR-71 aircraft all over the globe on a 24-hour basis. These daily sorties were a critical component of the eyes and ears of the free world as our nation kept close watch not only on our long-time adversary of the Cold War – the Soviet Union – but pretty much all of the Third World hot spots and rogue nations that appeared determined to cause the US and our allies as much trouble as possible during their own quests for power.

The action officers who staffed the SRC were all experienced former strategic reconnaissance crewmembers – pilots, recon systems officers, electronic warfare officers – relatively fresh out of the cockpit and sent to 'do their time' on headquarters staff jobs. The official Air Force reason for us being at least temporarily 'banished' from operational flying and sent to the headquarters staff was that we needed the opportunity for 'career-broadening' assignments to enhance our potential for eventual promotion. We all knew the real reason was that the senior leadership didn't want us to get the idea that all the Air Force was about was flying airplanes. Silly us …

Meanwhile, our counterparts at the Joint Reconnaissance Center in the Pentagon – also former recce crew dogs – did their best to decipher the myriad requirements they received daily from the military and civilian intelligence agencies demanding SR-71 coverage all over the world. The JRC would then pass those needs to us at SRC. The idea was for us to eventually task the SR-71 wing and operational detachments with specific missions in some reasonably clear terms that would allow the crews (our former squadron mates) to actually fly them.

It was while enjoying the holiday company of a group of friends, their wives, and significant others at one of those evening cocktail parties a few days before Christmas that my pager started to buzz. I had to fight off the urge to make believe I hadn't noticed it. I was finally beginning to relax and get into the holiday spirit, and now it appeared I was to be slapped back into reality by a call from 'Mother SAC'. I excused myself and called in to the SRC operations desk to see what was up. I was hoping it was just a routine notification of a sortie delayed or cancelled for weather somewhere very, very far away. No such luck. I was told by the duty officer that I was needed at the headquarters immediately, and that I should bypass the SRC and go directly to the tanker shop downstairs in the bowels of the headquarters building. I made my apologies to the hosts, and very reluctantly left the warm glow of the party for the cold, wet, snowy December streets of Omaha.

Driving toward the base, I was perplexed as to the reason for my recall. Not that I hadn't been called in at all odd hours many times before in the almost three years I had been chief of the SR-71 branch at SRC, it was just that normally the duty officer could give me a hint as to the reason. For example just the word 'delay' or 'cancel' or 'weather'

would be enough to give me the general idea of what was going on (without compromising classified information about specific missions, locations, times, etc) so I could begin to formulate possible options on my way to the base. Not this time. And being told to report to the tanker operations shop, rather than the SRC, was another surprise. Of course, we worked with the tanker guys all the time – their support was critical to the success of the SR mission. In fact, air-refuelling support for all kinds of fighter, bomber, reconnaissance, and mission support operations worldwide was coordinated and tasked through the tanker shop at SRC. They definitely had the 'big picture' as far as tanker availability and capabilities went.

As I walked into the tanker vault (pretty much all of the operations areas in the HQ SAC building were in secure 'walk-in vaults' where classified information could be openly displayed and readily handled by those authorized), I recognized most of the people standing around as tanker guys, some folks from the airborne command and control division, and a bunch of intelligence types. Almost all were in civilian clothes, as I was, since they had also been called in unexpectedly from what they thought would be a quiet evening with friends or family.

After a few more minutes, when someone decided that everyone who needed to be there had arrived, we were quieted down and the colonel who ran the tanker ops division stood up. He told us that SAC had just received orders from the Pentagon to develop plans for tanker and reconnaissance support of a bombing raid on Libya. The targets were to be terrorist training compounds and a number of various military facilities such as airfields, air defences, command and control centres, etc.

The raid would take place before dawn and be immediately followed (at first light) by an SR-71 overflight of the target areas to assess bomb damage, which would be critical in determining whether follow-on strikes would be necessary. My first thought was that the timing for the SR-71 overflight would put the crew overhead just when the Libyans were fully alerted … and very pissed off. Apparently, President Reagan finally decided he had just about enough of Muammar Gaddafi. The decision for the US response to Gaddafi was an interesting proposition to begin with, and it would become even more interesting as the mission plans evolved. The operation was to be called *Eldorado Canyon*.

The specific date for the attack was not given, but we were to begin planning our respective roles immediately, and have enough information assembled to provide an initial briefing to the SAC Deputy Commander for Operations and Director of Intelligence – both two-star generals – by 0700 the next morning, about 10 hours from our initial notification. It was going to be the first of many long nights. We obviously wouldn't have the whole operation nailed down in great detail by then, but we were to be prepared to present the various courses of action and recommendations to the SAC General Staff. Then the rest of our resources would be called in and we would begin in earnest to put together the many pieces of what would turn out to be a pretty complex operation. The actual attacks would be carried out by Navy fighter-bombers operating from a carrier in the Med and USAF F-111s flying out of RAF Lakenheath. They would be supported by USAF EF-111s (electronic jamming aircraft), a number of command and control aircraft and, of course, about a bazillion tankers.

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Obviously, the Navy and USAF fighter-bomber community did the planning for their attack aircraft. The USAF F-111 planners passed on their fuel load and mission timing requirements to SAC, and the SAC tanker crowd figured out how many and what types of tankers would be needed, where they could locate the tracks to safely (both militarily and politically) conduct air refuelling operations, where the tankers would operate from, and how and when to get them where they needed to be. This was never going to be an easy task, although it started out significantly less complex than it ended up.

The original concept for the Air Force strike component called for eight primary F-111 aircraft actually on target, with another four air spare aircraft launching and flying to a Go-No-Go point where they would be told whether they were needed or not (based upon the status of the primary aircraft). The 'operators' – the folks who knew the aircraft and mission capabilities first-hand and were best qualified to make the call – seemed pretty satisfied that those numbers would do the trick.

However, because the specific date for the attack had not yet been set (or at least it had not yet been shared with us planning the missions), there must have been sufficient time for more and more general officers to get involved in the game. The plan went through several increasingly complex evolutions until the final strike package of USAF F-111s reached 18 aircraft with six air spares. This, of course, exponentially increased the number of tanker aircraft required to get the 'armada' of airplanes from the UK to Libya and hopefully back again.

Just to make matters worse, several weeks into the process the planners were told that the French would not allow any US aircraft, strike or support, to overfly their landmass either on the way to, or returning from, the strike. All of the airplanes would have to fly south, just off the western coast of France, then turn east and thread their way through the straits of Gibraltar to get over the Mediterranean Sea. That translated into several more hours of flying time for all the aircraft, which in turn would require even more tankers than before. Eventually, the plan called for more than 20 KC-135 and KC-10 tanker aircraft to support the USAF strike force, not to mention the SR-71 primary and air spare aircraft. This was not going to be a low-profile operation. In fact, one of the most serious concerns was how to avoid mid-air collisions between the dozens of airplanes that would be traversing the extremely narrow gap of the Straits of Gibraltar in both directions within a short span of time, while radio silent and without being under air traffic control.

THE HABU MISSION

Fortunately for us recce types, that planning problem was one of many logistical and operational challenges that were left to the tanker troops to resolve. All we had to do

was put together a plan to get an SR-71 over all the targets on time, with cameras and electronic sensors blazing, defeat what we expected would be very alert and active Libyan defences, and then get the jet back to RAF Mildenhall. There, the mission take would be processed and the intelligence immediately disseminated to all the people who would be anxiously awaiting the strike results. Among those people were numerous military and civilian high rollers, including the chairman of the Joint Chiefs of Staff and the president of the United States, who wanted to be personally assured that the job had been done.

Normally, 'non-routine' SR-71 missions such as this one would be developed by the planners at the operational detachment from which the sortie was to be flown, and the plan would then be passed back to our people at the SR-71 branch of the SRC for review and approval. This made sense, since the folks at the dets were the ones who had first-hand knowledge of the operational environment in which the missions would be flown. However, in this case, there were way too many operational, logistical and political variables that were changing on an almost daily basis (and too many senior officers continuing to get involved) for the Det 4 mission planners to keep up with by themselves. Fortunately, in addition to the very capable and experienced planners at the detachments, we had a couple of pretty solid folks working the task at SRC, including one Maj Chuck Holte. Although Chuck was not a former SR-71 crewmember, he had extensive operational experience as an electronic warfare officer, having flown many real-world reconnaissance missions in the RC-135.

He was assigned to the SR-71 branch because of his in-depth knowledge of the ever-changing electronic threat environment, and his expertise was most welcome in not only planning specific SR-71 missions, but in helping us develop strategic plans for future defensive systems that would be needed for the SR-71's continued viability. Chuck's quiet, efficient manner and subtle sense of humour made him highly respected, and, equally importantly, very well liked and trusted by all the SR people who knew him, both at the headquarters and the operational sites. As a result, the Det 4 planners at RAF Mildenhall, from where this mission would be flown, welcomed his input in the planning process for this complex, highly visible tasking.

As the weeks and months went on and the Omaha winter gave way to spring, we still hadn't received a specific date for the attack. However, it seemed that every general in the building wanted daily updates on the plan. The plan, as initially envisioned and quite well laid out, would have been ready to go months earlier, but it seemed as though every general officer to whom it was briefed wanted another change or tweak, so it became the proverbial 'perpetual motion machine'. Consequently, most of us involved in planning the mission had worked every day and some nights, without a break, from the first night we were called out pre-Christmas. That pattern was to continue right up to the day of the attack in April, and for several weeks following, due to the same general officers wanting 'after action' reports and 'lesson learned' briefings.

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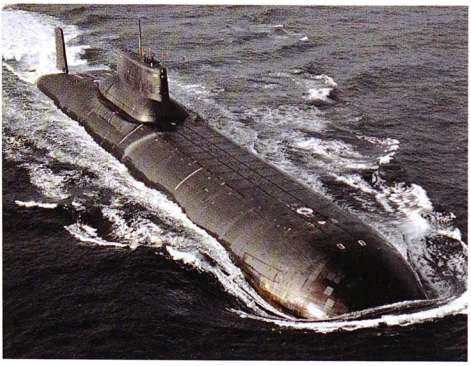
Chuck's patient nature allowed him to do a remarkable job keeping up with all the changes for the SR-71 mission plan and coordinating them with the Det 4 folks as they came up. Then one day in mid-spring, almost four months after we'd been given the order to develop the plan for the mission, the morning news headlines told of a terrorist bombing at the La Belle discotheque in Berlin. A number of people were killed and injured, among them American soldiers. Almost immediately, links were reported between the terrorist bombers and Libya. We had the feeling that would be the trigger for the president to give the go-ahead for the strike. We were right. The date for the attack was set for 15 April 1986 and the SR-71 plan was ready. At Det 4 – the 'pointy end of the spear' – the Habu crews and all their ops support, maintenance, intel and tanker support people were well prepared and waiting to go.

About 48 hours prior to the scheduled SR launch from Mildenhall, the CINCSAC's executive officer called down to SRC and said the general wanted my boss and me to come up to his office and brief him on the SR element of the mission. I dutifully folded up the mission charts, packed them into our secure briefcase, and the colonel and I weaved our way through the lower vaults of the headquarters building where we went about our classified work every day (and many nights). We eventually came to the stairs that took us up the several flights to where the sunlight and air were and, not surprisingly, the generals' offices.

As a frame of reference for this briefing, it was no secret that SAC did not like having the SR-71 in its operating budget. As I was also responsible for articulating and advocating the SR-71 operating budget within SAC, I was constantly locked in a state of mortal combat within the command to increase, or at times just sustain, funding for the flying hours we needed to meet our growing tasking. The problem was that the majority of that tasking was coming from many sources outside SAC, and even outside the Air Force. For example, the driving reason we established a permanent SR-71 detachment in Europe was to meet the US Navy's critical need to monitor the status of the Soviet Northern Fleet, and in particular its nuclear submarine operations out of Murmansk on the Barents Sea.

Once permanent SR-71 operations were set up and operating in Europe, the US Army realized we could provide excellent coverage of the Eastern Bloc countries around the Federal Republic of Germany, particularly during the darkness and cloud-covered weather of the European winter. The Army was also the primary driver of the regular coverage we provided to monitor hostile force status and movements in and around the Korean peninsula in the Pacific theatre.

SAC was not too happy about having to pick up the tab as the benevolent provider of all that great intelligence to other commands and services, especially when it felt it cut into funding for strategic bombers, intercontinental ballistic missiles and tankers. So it was no surprise that the CINC was not a huge supporter of the SR-71 programme (other than, of course, when SAC wanted to make a splash at air shows or other exhibitions, where the SR-71 was always its star performer and biggest crowd pleaser.)



▲ The pinnacle of Soviet SSBN design was epitomised by the enormously powerful Akula (Shark) class boats (NATO reporting name 'Typhoon'). Built at Shipyard 402 in Severodvinsk, with a submerged displacement of 48,000 tonnes, they were armed with six torpedo tubes and 20 R39 SLBMs, each containing 10 Multiple Independently Targeted Re-entry Vehicle (MIRV) nuclear warheads. Six were originally constructed, and to date they remain the largest submarines ever built. (Bellona Foundation)

The general had us lay out the chart with the SR-71 track on his desk, and we were to brief him straight from the map. I had gotten about as far as 'Sir, this is …' when he jabbed his finger at the two large rings representing the coverage of the Soviet-made SA-5 SAM sites, both of which were clearly bisected by the SR-71's planned track. One was located at Sirte, near the first target area at Benina airfield in eastern Libya, and the other at Tripoli, to the west. The CINC then asked (while continuing to stare at the very large circles on the map), 'Will these SA-5s be taken out prior to the SR going in?' My response, I thought at the time, was pretty obvious, even for a lowly major like me … 'Sir, we'll know if the sites were destroyed when the SR returns and the intel folks analyze the take.' Wrong answer. The remainder of the 'briefing' went something like this:

The General: 'I don't want the airplane penetrating those SAMs unless we know they've been neutralized prior to the pass.'

The Lowly Major: 'Sir, there is no way for the SR to collect all of the tasked targets without going through the SA-5 coverage. The SR will be at better than Mach 3 and at or above 80,000ft. The best intel we have on the SA-5 and the SR's ability to defeat it with the airplane's combination of on-board systems and speed and altitude puts this at an acceptable risk level for the mission.'

The General: 'Like I said, Major, I don't want the SR to penetrate those rings unless we know the sites have been taken out.'

The Lowly Major: 'Sir, if we could just …'

The General (this time in a clearly angered tone): *'Major – you are not listening – I'm not going to risk one of MY SR-71s for this piddly little operation!!'*

The Lowly Major: (in thought only …) 'One of *"his"* SR-71s?' *"Piddly little operation!'*

End of discussion. End of briefing. Back to the drawing boards and with less than 48 hours to come up with an alternative approach.

Although the SA-5 was the most modern and only existing Soviet SAM system with a postulated capability against the SR-71, none had yet been fired at the Habu, and therefore its capability against a high-altitude, Mach 3+ manoeuvring target was still hypothetical. Additionally, we had more than reasonable confidence in the SR-71's on-board electronic defensive systems, when coupled with the airplane's speed and altitude, to handle the threat. On top of all that, this was the very type of mission for which the SR-71 had been designed and had proven itself so well in successfully accomplishing for over 20 years. In fact, even when the programme was eventually terminated four years later, the SR-71 could boast a record that no other USAF aircraft could claim. That is – after 26 years of operational service and hundreds of missions over and around hostile territory, with dozens of SA-2 SAM firings against it during the Vietnam War alone – not a single Air Force crewmember had ever been killed in an SR-71, and none had ever been lost to enemy action.

Notwithstanding the reality of all that, we were clearly going to have to come up with another approach if we were going to meet the tasking that had been levied on us. (In hindsight, if we *failed* to come up with a workable plan, this would have been

a perfect way for SAC to say that the SR was tasked, but couldn't support the mission. Another arrow in its quiver to get rid of the programme.)

After a lot of scurrying and many secure phone calls, we were told by our people in D.C. that there was a *slight* possibility the status of the SA-5 sites could be assessed (by a highly classified intelligence source) in the short period between the time that the last bomb was dropped and the SR-71 came over the target. So we came up with another plan that none of us liked very much.

▲ The S-200 Wega, or SA-5 "Gammon" long-range surface-to-air missile was used extensively by the Soviet Union and a number of its allies. One is seen here in service with the German Democratic Republic, where it was operated by the Nationale Volksarmee (NVA). (Luftwaffe via Stefan Büttner)

The status of the SAM sites, if known by then, could be transmitted via satellite communications to the KC-10 tanker that would be waiting for the SR-71 over the Mediterranean Sea prior to the SR accelerating into the target area. Once the SR-71 was on the tanker's boom and taking gas, the tanker crew would simply pass the words 'Option Alpha' or 'Option Bravo' to the SR crew via the secure boom interphone. The SR-71 RSO would then select one of two flight paths pre-programmed into the ANS computer.

From the end of the air refuelling track, 'Option A' would direct the airplane along the originally planned flight path directly through the SA-5 rings, assuming that intel confirmed the sites had been destroyed. If the sites were either confirmed as still operational, or the information simply wasn't available, then the RSO would select 'Option B', which would take the SR on a peripheral flight path just skirting the operational range of the SA-5s. This flight path would obviously allow the SR-71 to avoid the potential SA-5 threat, but it would also unfortunately reduce the number of targets its sensors could collect, and therefore degrade the usefulness of the intelligence it would bring back.

We at SRC didn't like this plan for any number of reasons. First of all, no SR-71 crew liked to mess around with the ANS once the aircraft was airborne and operating smoothly. The system was certainly capable of doing what was planned in this case, but it just didn't feel right to the crews. But more importantly, by not allowing the SR to fly the mission as originally planned to acquire all the tasked damage assessment of the targets hit by the strike force, there was a great risk of not knowing what was and what wasn't destroyed. This would very likely result in sending more aircraft in for a second strike. As it was, we lost one F-111 crew in the first attack. Another strike, especially if launched unnecessarily – only because the SR-71 wasn't allowed to confirm the targets had already been hit – would just expose more aircrews to the danger of losing their lives for no reason.

But, as ordered, we passed the revised 'Option A and B' plan to the Det planners, and they prepared to execute it as the SR's launch time approached. Frustration levels were high all around. This was one of those times when the crews on the line, getting ready to fly the mission, no doubt wondered what in the world was going on in the minds of their former crewmates at the headquarters who tasked this crazy sortie.

As somewhat of an anticlimax, the 'Option A and B' plan was scrapped for some reason undisclosed to us pretty much at the last hour. The SR crew wound up flying the mission as originally tasked and obviously survived the SA-5 threat to come back with the take. No surprise to those of us who knew and understood the Habu and its incredible capabilities. It is not unreasonable to speculate that the 'highly classified source' that was supposed to provide the status of the SAM sites prior to the SR going in wasn't up to the task, and the SAC general staff was beginning to feel the pressure,

both from the Joint Staff and from the White House, to produce the much-needed intelligence.

THE DET COMMANDER

Lt Col Barry MacKean was the Det 4 commander during this period and it was he and his team that had to implement the plan, as he recalls:

> Planning for the raids on Libya in April 1986 began weeks before the actual flights. Lt Col Frank Stampf from the Strategic Reconnaissance Center at HQ Strategic Air Command in Omaha, Nebraska initially advised me of the pending operation, code-named *Eldorado Canyon*. At that point everything was handled as Top Secret because of the implications of overflying foreign territory. There was also a great deal of uncertainty about whether the missions would ever be flown due to the necessary approvals required from several foreign countries, most notably the British government. US Air Force involvement in the plan was to be exclusively executed from England.
>
> The F-111 strike would launch from RAF Lakenheath, the EF-111 Raven electronic support aircraft from RAF Upper Heyford, KC-135 and KC-10 refuelling support from RAF Fairford and RAF Mildenhall, while the SR-71 reconnaissance support would also be fielded from Mildenhall. Given the enormity of the plan, world sensitivities at the time and the lack of British involvement, I had my doubts that Prime Minister Margaret Thatcher would approve air strikes flown from England. But fortunately for the free world, and in spite of mounting opposition from within her own party as well as that of Labour, she ultimately approved the missions.
>
> The SR-71 mission was to provide bomb damage assessment for all the target areas struck in Libya; US Navy fighters were targeted against Benghazi in the eastern part of Libya, while the Air Force was targeted against Tripoli and the surrounding area. An additional burden was placed on all Air Force sorties to fly around France, Spain, Portugal and then through the Straits of Gibraltar, because France refused overflight clearance.
>
> The sensor chosen by the Pentagon for the Blackbird mission was the suite of highly sensitive cameras. This choice was based on its ability to declassify the photo images for release to the world press, whereas products generated from our high-resolution radar system would reveal their capabilities and therefore could not be declassified. This decision would prove costly because, while the radar was day/night all-weather capable, the cameras were definitely restricted to daytime operations and clear weather.
>
> Our mission planning team, led by Maj Bruce Blakely under the supervision of the director of operations, Lt Col Bob Behler, developed a very creative flight profile for the Blackbird that maximized target collection while minimizing exposure to surface-to-air missiles and Libyan fighters. Since we had previously flown missions into the eastern Mediterranean area, the same air-refuelling route was selected to help disguise this mission. It consisted of a high-altitude route that unexpectedly turned back to the west covering the targets in eastern Libya and proceeded at Mach 3+ to the capital, Tripoli, before the air defence systems could respond.
>
> When it appeared *Eldorado Canyon* 'might' be approved, the build up of tanker aircraft, both KC-10s and KC-135s, began at RAF Mildenhall. Part of the cover story for this highly visible addition of tankers parked everywhere was that a large European

exercise, normally scheduled for this time of year, was taking place. There were even photos and stories in the local newspapers to that effect, which helped minimize any potential leaks. To further add credence to the cover and disguise the real operation, at 5am on the morning of the actual mission (the strike aircraft and tankers launched around 5pm in England), the 48th Tactical Fighter Wing at RAF Lakenheath initiated a typical base 'exercise'. This included a recall of all military personnel to their duty stations, generation of aircraft for alert, including uploading conventional weapons, and general exercise activities. Many of the 'exercise' participants were completely unaware of what was about to happen later that day.

Launch of the strike force and tankers occurred in the late afternoon on Monday 15 April. The day prior (Sunday), I received a call from Lt Col Stampf at SRC directing us to cancel our regularly scheduled sorties and configure both of our jets for the pending Libyan mission. One aircraft was designated as primary, the other scheduled to follow a little more than an hour later as back-up, in case the primary aircraft had to abort for aircraft or sensor problems.

▲ Operation *Eldorado Canyon* established a stream of Det 4 firsts, not least the first time within Europe that KC-10 tankers were used to refuel the Habu. (Lockheed Martin)

Our maintenance team, led by Mr Mel Rushing, consisted of 45 Lockheed personnel with 15 subcontractors and associates from other companies that supported systems/sensors on the aircraft. I had two blue-suit [Air Force] technical sergeants (Robby Butterfield and Jerry Gresham) that provided me quality assurance of the contractor maintenance. The intelligence branch consisted of about 100 military personnel led by Maj Rod Mitchell. This team provided the targeting data for mission planning, processed the film after the mission, analyzed the imagery for weapons' effects, and managed all the electrical and conditioned air requirements for the American systems operating under British standards. Bottom line, the entire team was extremely anxious to participate in Operation *Eldorado Canyon*.

Our scheduled launch time was 5am on Tuesday 16 April, to allow for enough light in the target areas to effectively expose the camera film and reveal the damage. With our aircraft and team in full readiness, I departed my office around 5pm for my on-base quarters located at RAF Lakenheath. My staff car was equipped with UHF/VHF radios that allowed me to monitor our operation, as well as that of the tower at RAF Mildenhall. The most amazing thing was happening on the taxiways and runway – tankers were taxiing and taking off with no communication with the tower or departure control. The entire operation was what we call 'comm out' – all movement and approvals were done with lights from the tower, based on timing. It was truly an amazing sight to behold!

As I approached my quarters, I witnessed the same 'comm out' launch of the F-111s, fully loaded with their conventional stores. My wife Terri, an Air Force nurse stationed at the hospital at RAF Lakenheath, had participated in the early morning exercise/recall that day. When I entered the house she told me how for the first time ever, an exercise was terminated early. The cover story was that the exercise had gone

so well, the wing staff chose to terminate the remaining events. I gave her a set of binoculars and told her to look at the next F-111 that took off. She too was amazed to see the conventional weapons on the wings. I then told her about *Eldorado Canyon*.

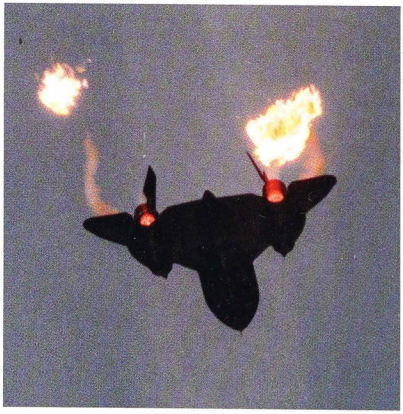
After a few hours of restless sleep I returned to our unit to find everything in perfect shape. We launched the primary aircraft flown by Lt Col Jerry Glasser and Maj Ron Tabor uneventfully 'on the hack', comm out. After our spare aircraft, flown by Maj Brian Shul and Maj Walt Watson, launched successfully, several of us went for breakfast. As we got out of the car, the F-111s were returning one by one back into RAF Lakenheath, but this time, there were no weapons on the wings – definitely an eerie sight watching combat aircraft return. One F-111 was lost with its crew and another had to land in Spain with engine problems.

Remember the earlier comment about cameras requiring good weather? Well, we encountered our nemesis, cloud cover over the target area. The primary aircraft flew perfectly and did everything required, our problem was clouds. Both aircraft came back 'code one', meaning not one maintenance discrepancy. Before we even received word from SRC as to a return engagement, I had the maintenance teams preparing both aircraft for possible flights the next day. Everyone was so mission-oriented, there was no problem making it happen. While we awaited the go-ahead from SRC, our intelligence team was pouring over the film with hopes of getting enough usable imagery to complete a full BDA report. Unfortunately, when it came to the area around Tripoli, there was none to be had.

With SRC approval, we swapped the aircrews and jets and flew the very next day. Our mission planners cleverly altered the flight plan to preclude predictability and to minimize potential threats. However, on this occasion the lead aircraft experienced a malfunction of the optical bar camera. Although the other cameras performed flawlessly, the target areas were obscured by sand storms. Because of the high level of national interest, joining our imagery analysts to review the film was Maj Gen Thomas McInerny, the Third Air Force commander, stationed at RAF Mildenhall. He understood we had no control over Mother Nature and was very supportive of the efforts of our personnel. However, senior leadership was adamant that we provide releasable BDA.

Without missing a beat, our team prepared both aircraft for a third consecutive flight. SRC gave approval and the two jets departed RAF Mildenhall for the third and finally successful time. This time the primary crew was Lt Col Bernie Smith and Lt Col Denny Whalen, with the spare crew being Lt Col Jerry Glasser and Maj Ron Tabor. As fate would have it, the target area was clear and we were able to provide good BDA as tasked. However, this was all very frustrating to us in the 'recce' team because we knew that we could have provided BDA imagery after the very first sortie, had we been allowed to use our very sophisticated radar system.

Besides finally providing the much-sought-after BDA, our team established a benchmark for SR-71 sorties generated and flown that was and remains unparalleled. We flew six sorties in three days with only two aircraft, supported by a maintenance team that was staffed to support only two to three sorties a week. As the commander of the unit, I was extremely proud of their accomplishments and the manner in which everyone pulled together. Definitely in keeping with the Habu tradition!



▼ The Habu was always a spectacular air show performer, even though it was flying way below its optimum envelope. As the high point of Mildenhall's Air Fêtes, the aircraft was always flown with enthusiasm. '973 was overstressed during the May 1987 event, and more than one display resulted in dramatic fireballs as the afterburners ignited clouds of unburnt JP-7 fuel. (Ted Eden)

MISSION EXECUTION

Lt Col Jerry Glasser, an SR-71 instructor pilot and director of simulator training, with over 900 hours of Habu flight time already under his belt, together with his RSO Maj Ron Tabor, an RSO instructor and the chief back-seat simulator instructor, were the primary aircraft crew for BDA after the attack. Majors Brian Shul and his RSO Walt Watson were nominated to fly backup first time around. A third crew, Lt Col Bernie Smith, the Chief of Stan-Board, and instructor RSO Lt Col Dennie Whalen were en route to join their colleagues via KC-135; they would fly a later mission over Libya. Jerry provides a unique insight into that first sortie:

> As the tasking came down and the F-111s geared up, we were directed to equip the aircraft with optical sensors, an OBC in the nose and TEOCs in the chine bays. The weather could always be a problem with visual sensors, but they provided the best image quality and this was very important for Washington.
>
> The plan was to launch the two aircraft with a time interval between them that would ensure that if all went according to plan, primary would just be coming off the target as the back-up air spare was just about to turn into the Mediterranean refuelling track. If primary had sustained some kind of mechanical or sensor malfunction, back-up would continue into the area and get the take. If, however, primary cleared the target area and reported 'ops normal', back-up would turn back to England prior to the Straits of Gibraltar. Three air refuelling tracks were planned to support the mission, one off Land's End, England and two in the Mediterranean.
>
> An area of concern for us as crewmembers was the decision that the second air refuelling in the Med was to be conducted from a KC-10 at 31,000ft. This was 6,000ft above our usual refuelling block altitude. Checking the Mach/IAS limits for the KC-10 confirmed that we'd be 'well behind the subsonic power curve while behind the boom.' From what I recall, even the KC-10/SR-71 compatibility checks carried out at Palmdale didn't get up to 31,000ft. A second and common problem, as we learned later at first-hand, was the 'brutal sun angle', which would be directly down the boom.
>
> Mission brief was at 3:00am. Brian and Walt were also our mobile crew, so after seeing us off, they had to get suited and launch as airborne back-up. Our route was subsonic to Land's End, where we'd be topped off by two KC-135s. We'd then climb and accelerate south along the Portuguese coast, then make a left turn through the Straits of Gibraltar, decel and refuel in the western Med. Our second accel was on an easterly heading and we'd then make a right, climbing turn to the south and head directly for our first target – Benghazi. We'd then perform a hard right to slip by the SA-5 sites at Sirte and then fly on to Tripoli, our second target. The plan then called for a post target decel for our third and final AR in the western Med before our final accel exiting again through the Straits, then on to a northerly heading that would take us back to the UK.

The main thrust of the strike was to be conducted by 18 F-111Fs from RAF Lakenheath, split into six flights of three aircraft each using call signs Puffy, Lujan, Remit, Elton, Karma and Jewel. More than 20 KC-10s and KC-135s provided air-refuelling support for the strike force. In addition, three EF-111 Ravens provided ECM support.

Hours before the Habu launched, the first of its support tankers got airborne, as four KC-135s and KC-10s left the base for their refueling orbits:

> Finey 50 and Finey 51 launched at 0230 and 0240 hours (KC-135 59-1520 and KC-

10 83-0079)
Finey 52 and Finey 53 launched at 0402 and 0405 hours (KC-135 58-0125 and KC-10 83-0082)
Finey 54 and Finey 55 launched at 0412 and 0415 hours (KC-135s 60-0342 and 58-0094)
Finey 56 launched at 0740 hours (KC-10 83-0075)

Lt Col Jerry Glasser and Maj Ron Tabor took off as scheduled at 0500 in SR-71 '980 (call sign Tromp 30), and Jerry continues:

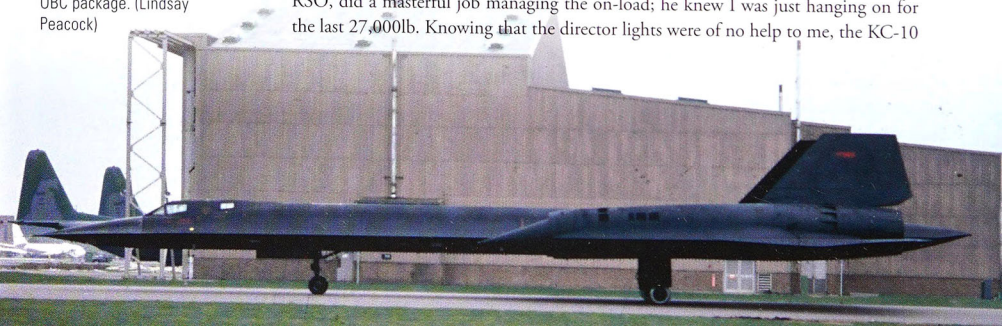
For take-off we carried 55,000lb of fuel, which was 10,000lb more than normal. A night launch down Mildenhall's 8,500ft runway was always exciting. From a safety aspect, I always had concerns for the buildings at the end of runway 29, especially when we were heavy.

We rendezvoused as planned with Finey 54 and Finey 55, which had entered a holding pattern off the southwest coast of England. Our first AR was fine except for a little turbulence; we then made our first accel towards the Med. The early morning accel with the sunrise and the coast of Europe to the left painted a wonderful scene and the turn through the Straits of Gibraltar was quite spectacular – we were prohibited from taking random photos of the Straits.

Our second AR had a KC-135Q acting as lead to a KC-10 in trail; this was due to the special comm/ranging equipment carried by our tankers. We thought it was overkill, but it worked out fine. The '135 flew one mile ahead of the KC-10 and we ranged on both. The weather was clear, but the sun angle was a big problem. This refuelling, scheduled for 31,500ft, was the highest ever attempted in the SR-71. Apparently the planners wanted to stay above the major airways and have a 500ft separation with IFR traffic. We didn't know of this until the morning of the mission and were a bit surprised!

As we hooked up at 31,000ft I couldn't see the tanker's director lights due to the glare. The KC-10 was airspeed and Mach limited at that altitude and couldn't accelerate to 350KIAS after the hook-up. We were well behind the power curve, flying slower than 300KIAS, but I'd talked to the KC-10 boomer prior to the mission and this proved to be an invaluable conversation – as a result, he fully understood the speed/altitude incompatibility issue and that the sun angle was likely to cause a problem. I had two boom disconnects before I settled down, and to further help reduce the glare, Ron got the tanker to turn 10° right and I 'hid' under its number one engine nacelle.

To stay on the boom we had to go to afterburner at 55,000lb compared to 76–77,000lb, where we'd normally engage the left 'burner (depending on the outside air temperature) to get a full fuel load from a KC-135 at our usual altitude. Ron, my RSO, did a masterful job managing the on-load; he knew I was just hanging on for the last 27,000lb. Knowing that the director lights were of no help to me, the KC-10



▼ Lt Col Jerry Glasser and RSO Major Ron Tabor taxi 980 back to its barn after a very busy night's work recording the results of USAF and US Navy air strikes on Libya during Operation *Eldorado Canyon*. Note the 'glass nose' containing the OBC package. (Lindsay Peacock)

boomer also did a fine job keeping us plugged in. We had the right engine at Mil power and were modulating the left afterburner to stay on the boom. The boomer had not seen that before and was getting concerned over the bank angle for the disconnect, but it worked out. I have to say, I completed many air refuellings in the SR, in good and bad weather, pitch black night, even in an area we called the 'black hole' off Kadena over the Pacific, at night, with no moon and rough weather, but that second AR was my most challenging.

As we began the second accel the right A/B wouldn't light, but a little manual rise in exhaust temperature, together with another shot of TEB, and we were off again. We entered a solid cirrus deck at 41,000ft and I began to get a little concerned, since we didn't break out until we reached 60,000ft. However, as soon as we were clear, there dead ahead of us was the coast of Africa and Ron got set for the Benghazi take. As we levelled off at 75,000ft and our cruising speed of Mach 3.15, the bird was running just beautifully. I knew to leave Ron alone during this phase, as he was really busy. The DEF warning lights started to flash and Ron signalled that all was a GO. The take seemed normal as we made our hard right turn towards Tripoli and we were tuned for the SA-5 site at Sirte. Again warning lights flashed, but nothing was visible – we truly felt invincible at Mach 3.15.

The weather over Tripoli wasn't good. As we completed the run and turned out of the area, Ron gave an 'ops normal' call, so Brian and Walt, who were fast approaching the pre-designated abort point, made a right turn short of Gibraltar and headed back to Mildenhall. As it subsequently turned out, morning fog cut out some of the optical take around Tripoli and two more missions would be required to complete the BDA picture – one due to weather, the other to sensor failure (the OBC).

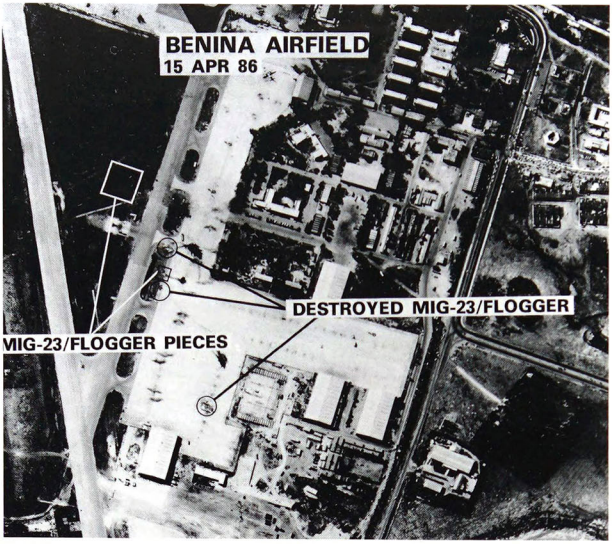
Our third and final refuelling, conducted down at 26,000ft, was uneventful; we pressure disconnected off the boom and headed home, once again through the Straits. The remainder of the mission was 'normal, normal, normal', as Ron and I made our final descent into the UK and called 'London Mil'. I still plainly recall the impeccable English that gave us both a little lift, 'Good morning, gentlemen, it's been a long day for you.' It's with some nostalgia and a great sense of pride that I enjoyed such a professional association with British controllers. As we were handed over to the various controlling agencies on our way back to Mildenhall, we were eventually vectored to runway 11 for a GCA approach.

The landing was uneventful and as we taxied back to the 'barn', there were Brian, Walt, Bernie and Dennie in the mobile car to greet us. But, as was my habit, as I stepped from the gantry ladder the people I first made sure to shake hands with were the maintenance chiefs, who, through their professionalism, had enabled Ron and I to fulfill our part of the mission.

As planned, Majs Brian Shul and Walt Watson had launched at 0615 hours in aircraft '960 (call sign Tromp 31) and duplicated the route flown by Glasser and Tabor to the first ARCP with Finey 54 and 55 off Cornwall. Shul spotted the returning F-111s approaching head-on several thousand feet below. Lujac 21's pilot (the F-111 flight leader) rocked his wings in recognition and Shul returned the time-honoured aviation salute with a similar manoeuvre.

The final tanker (KC-10 83-0075) joined *Eldorado Canyon* to support the return of the two Habus.

At 0910 a KC-135Q (call sign Java 90) landed at Mildenhall carrying senior members of the 9th SRW staff from Beale to witness the mission debriefing. Twenty minutes later, tankers Finey 54 and 55 touched down, followed at 0935 by Tromp 30, which had flown a mission



▲ One of two SR-71 images released to the world's media but never officially credited. (USAF)

lasting 4½ hours. One hour and 13 minutes later, Shul and Watson landed the Habu back up. The five remaining tankers returned over the next 4½ hours. Finey 51 flew a 12½-hour sortie. When Finey 56 landed at 1526 hours, *Eldorado Canyon* was completed, with the exception of search efforts for Captains Ribas-Dominicci and Lorance, whose F-111 had been lost the previous night off the coast of Libya.

The mission's take was processed in the Mobile Processing Center and it was then transported by a KC-135 (Trout 99) to Andrews AFB, Maryland (only 25 miles from the Pentagon and White House), where national-level officials were eagerly awaiting post-strike briefings. The world's news media had been quick to show the bad side of the story, with BBC reporter Kate Adie used as a propaganda dupe to show not only where one F-111's bomb load went astray near the French embassy, but also where Libyan SAMs had fallen back on the city but were claimed to be US bombs. But she also provided useful post-strike reconnaissance by showing the accurately bombed terrorist camp, referred to by her as a 'cadet school'.

The marginal weather around the Libyan capital forced another Habu sortie to be flown the following day. This time Jerry and Ron were back up in aircraft '980 for Brian and Walt, who were the primary crew in aircraft '960; Bernie and Dennie were the mobile crew, charged with overseeing the launches and recoveries back into Mildenhall. During the sortie the primary aircraft suffered a sensor failure and for unknown reasons the back-up aircraft, which was in the air and operational, wasn't contacted. This required a third mission, completed on 17 April by Bernie and Dennie as the primary crew in aircraft '980, backed up by Brian and Walt in '960. To preserve security, the mission call signs were changed, Fatty and Lute being allocated to the tankers and SR-71s, respectively, for the 16 April mission, and Minor and Phony used the next day.

Some commentators have claimed that the Libyans fired SAMs at the SR-71s during these missions. This has been confirmed as definitively not the case by Lt Col Ron Tabor, who in addition to flying the first mission, was also a senior RSO and instructor. In addition, Lt Col Frank Stampf said, 'We at SAC HQ, along with several other "special" agencies monitoring the progress of the mission in real time and looking for enemy reactions, saw no evidence of an actual launch after the fact.'

Photos taken in the vicinity of Benghazi by Tromp 30 on 15 April were released to the press, although the source was never officially admitted and image quality was purposely degraded to hide the system's true capabilities.

Bellicose rumblings from Gaddafi continued after the raid, and 14 months later, the west's intelligence services believed that Libya had received a number of MiG-29 "Fulcrums". This outstanding fighter would considerably enhance Libya's air defence network. It was therefore

decided that Det 4 should fly another series of sorties over the Libyan region to try and confirm these intelligence reports.

On 27, 28 and 30 August, both SR-71s were launched from Mildenhall to photograph all the Libyan bases. Tanker support for each operation consisted of three KC-135s and two KC-10s. The tankers and the Habus used the call signs Mug, Sokey and Baffy. Two other KC-135s (Gammit 99 and Myer 99) flew courier missions to Andrews AFB, Maryland on 29 August and 9 September to transport the take to the Pentagon, where intelligence analysts failed to find the MiGs they had suspected.

Thereafter, until 22 December 1988, it appeared as though the Libyan leader and his regime might have learned a lesson about US intolerance of international terrorism. However, on that night, high over the small Scottish town of Lockerbie, Pan American Boeing 747 Flight 102 was blown from the sky by a Libyan bomb. In all, 259 passengers and crew and at least 11 people on the ground were killed, making this Britain's worst air disaster.

▲ Following Det 4's unprecedented operational effort between 15 and 17 April 1986, 61-7980 emerged with mission marks in the form of three red camels, applied to the left nose-gear door. (Paul F. Crickmore)

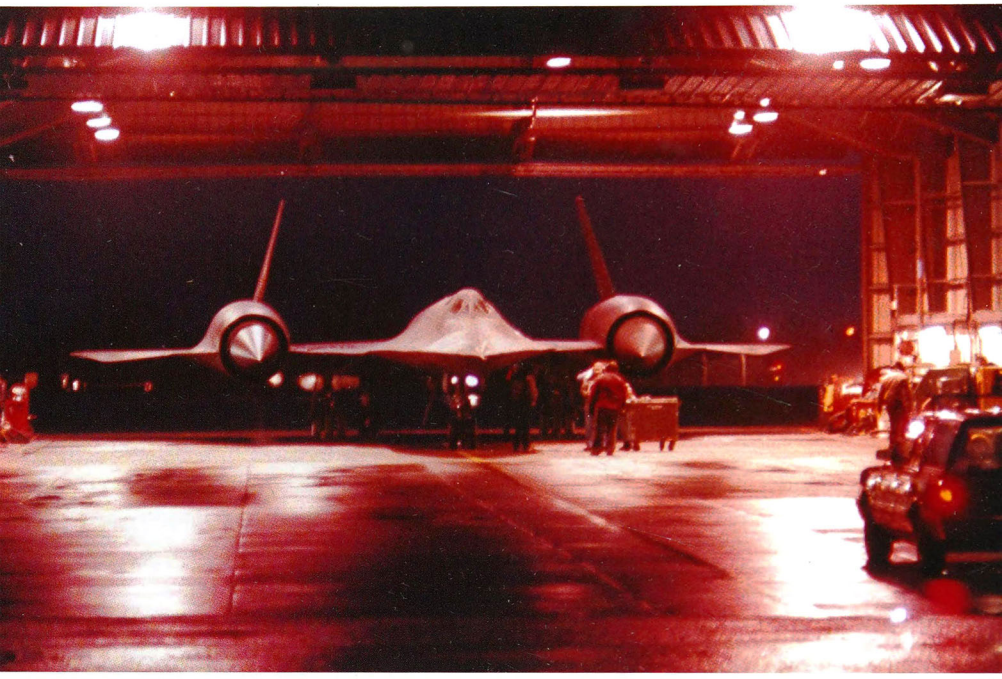
DET 4'S NEAR LOSSES

On 29 June 1987, Majs Duane Noll and Tom Veltri launched in '964 for a Barents/Baltic mission. They had just completed their anti-clockwise run off the coasts of Lithuania, Latvia and Estonia when there was an explosion in the aircraft's right engine. Since denied territory was off to their right, they had no alternative but to turn left, decelerate and descend. They were north of Gotland, and as the aircraft descended, Tom turned on the IFF and declared an emergency on guard frequency. He takes up the story:

> That got the Swedes' attention and a pair of Viggens was on our wing before we reached 18,000ft. Given that the Soviets were monitoring our activity, I was glad to see a friendly escort. We later found out that the Soviets had launched numerous fighters with orders to force us to land in Soviet territory or shoot us down. The descent from 80,000 to 25,000ft, where the plane began to stabilize, took just a few minutes. The Viggens continued to escort us through the Baltic and along the Polish and East German borders until F-15s out of West Germany intercepted and took over escort duties, but the worst was not yet over.
>
> Since fuel constraints made it impossible to make it back to Mildenhall, we were forced to land at Nordhiltz AB, West Germany. The engine explosion also caused the complete loss of our auxiliary hydraulic fluids, which meant no brakes or steering on landing. The base closed off all roads surrounding the base prior to our arrival in anticipation of our going off the runway. Fortunately for everyone, there was just enough residual hydraulic fluid left in the lines for one application of the brakes. The airplane stopped just short of the end of the runway and that's where we left it for the rest of the day until a maintenance crew from Mildenhall arrived and moved it.

During the late autumn, the det again came within a breath of losing an aircraft, as Larry Brown explains:

> Keith and I were scheduled to launch at 17:30 local time for a Barents mission on the evening of 20 October 1987, in aircraft '980. There was weather forecasted in the refuelling area off the coast of Norway; this was our first tour to Det 4 so we were the



▲ All buttoned down, 61-7964 prepares to leave the Det 4 barn on a Barents/Baltic Seas mission on 17 December 1987. Ground technicians would have begun their activities 4½ hours earlier. Their first task was to warm the tar-like engine oil prior to start up, which in UK winter temperatures cooled to a solid mass. (Paul F. Crickmore)

new guys. Mike Smith and Doug Soifer were actually scheduled for this mission, but due to a conflict with another activity we swapped flights.

Launch went as scheduled and the aircraft performed well throughout as we exited the sensitive area. Our descent profile into the last refuelling track was going well with our altitude profile in check. So far, a great mission. We had a good lock-on with the tanker's ranging system and fuel was above planned. Just one more hook-up, accel, and we'd be back on the ground in no time, or so I thought …

Decelerating through Mach 1.3, we completed our final decel checklist. Altitude was on profile and as we passed through 31,000ft, the triple display indicator showed us decelerating through the Mach to subsonic speed. 'OK Larry, range 40 to go, ready with the refuelling checks,' Keith said. 'OK, go with the checks.' By level off at 26,000ft, we had completed our refuelling checks and now we could concentrate on the rendezvous. Our range to the tanker quickly counted down to 20 miles as the tanker made the final turn that would put us in trail and on the same heading. There was no moon or horizon and everything outside looked pretty black. At 10 miles range, I picked up the tanker's lights, which were in a left turn about 10° off the nose. At 5 miles, I began a slow descent to their altitude of 25,000ft.

The tanker had just about rolled out on heading and I began to slowly retard the throttles back to begin slowing from 0.9 Mach. Moments later I heard something through my earphones that seemed to be a high-pitched buzzing sound, similar to the sound when switching the generators on after engine start during ground operations. Immediately, the master warning light illuminated, signalling me to check the telelight panel. I glanced down to discover an amber 'R GEN OFF' light illuminated, indicating

that the right engine-driven AC generator had disconnected from the main bus. In the SR we had two AC generators, each driven by its respective engine. The electrical system, as with other aircraft, was designed with an AC bus tie to allow the other generator to power the AC electrical requirements in case the other dropped offline.

My first reaction was to look back up at the tanker. I was at their altitude with closure speed and needed to first stabilize our position behind them before working our problem. As I stabilized behind the tanker, I told Keith we had a right generator off light and he responded that we had also lost the ANS, which was our primary navigation system. We went ahead and hooked up with the tanker, taking on 5,000lb of fuel before disconnecting.

The nature of a single generator out was not a serious emergency, especially since the other generator had picked up the load. I knew we had two chances to reset it; otherwise it was mandatory for us to land as soon as possible. After going through the checks, the generator dropped off again and then again. Now we had no choice but to divert to Bodø, Norway. We explained to the tanker crew the nature of our problem and directed them to proceed to Bodø. I elected to remain on their wing until we had everything ironed out before taking the lead. Since the tanker had a good platform and navigation system, the choice was simple to keep them in front, especially considering the solid deck of weather, night and no moon!

We again hooked back up with the tanker for an additional 10,000lb of fuel – one thing I didn't need was to make a poor situation even worse by running low on fuel, just in case we had to go somewhere other than Bodø. I then slid back on the tanker, flying a loose formation. We finished up our checks and prepared for the approach, setting up the ILS and TACAN. We were still too far out for a check on the ILS and our TACAN wouldn't lock on, but the INS seemed to be OK. One of our UHF radios was on the tanker's frequency and the other with ATC.

With 70 miles to go, I could see we were too high and tried to communicate with the tanker, but with no luck. I kept trying, but got no reply and we were not receiving ATC either. Fuel looked good at 28,000lb but the CG was getting aft, so I began to transfer fuel to the forward tanks. We then tried the VHF radios and guard, but again, no luck. As we penetrated the deck, the tanker began a left turn away from where I thought we should be heading; now I wasn't sure if Bodø was closed, or if the tanker was just circling to get down. We were getting ready to try them on the HF radio when we heard them over guard, 'come up on victor 127.0.' Having finally made contact, I planned on getting a position check, but then things really took a turn for the worse.

The floodlights suddenly came on, making it extremely bright in the cockpit and very difficult to see the tanker. At about the same time that familiar buzzing sound came through my headphones. I immediately looked down at the telelight panel to discover a host of amber caution and red warning lights. The two red warning lights that caught my attention were the LEFT and RIGHT ENGINE FUEL LOW PRESSURE lights, indicating loss of our remaining generator and imminent engine failure. I immediately placed both generator control switches to the emergency position as called for by the bold face procedures. Keith, also aware of the failure, called out the bold face actions without hesitation. Now, I went from bright floods to very dim lighting. However, my immediate concern was the back-up AC generator system (also known as emergency generators) and the supply of AC power to the fuel tank boost pumps ensuring fuel pressure to the engines. I quickly looked down to where my fuel control panel was supposed to be located, but the entire panel was black, with no lighting whatsoever. To further complicate matters, none of the fuel

▲ Majors Jim Jiggens and Ted Ross launch 61-7964, call sign Sheik 99, from a snowy Mildenhall in February 1987. (Paul F. Crickmore)

tank selection buttons illuminated, either because the pumps were tripped off or no power was going to any of the status indicator lights.

I then remembered a warning in the manual stating that during emergency AC operation, the normal auto fuel sequencing system is disabled and the pilot must manually select the tanks. Auto transfer and ullage systems would also be inoperative. I felt across my panel until I located the tank selection buttons, then beginning from the top I counted down, including the cross-feed button, to the fifth button and pushed it in, which was tank 4. Tank 4 had the most fuel, and feed from this tank would have less impact on the centre of gravity. I still had no tank 4 'ON', light but observed that both red LEFT and RIGHT ENGINE FUEL LOW PRESSURE lights went out, indicating at least some of the four boost pumps in tank 4 were operating and supplying adequate fuel pressure to the engines.

Now, at last, I had a chance to assess our situation. We were still over water, north of the Arctic Circle and it was hours before sunrise – this would make for a very serious situation if it became necessary for us to bail out. In the SR-71, fuel boost pumps are required to sustain engine operation. These pumps operate under AC voltage and required high enough current that only the engine-driven AC generators could deliver. If one generator failed or dropped offline for any number of reasons, then the electrical crossover system provided AC voltage from the remaining AC generator. However, if a failure also occurred in the other AC generator, then the boost pumps failed to supply fuel to the engines. To guard against this remote possibility, an emergency back up feature was installed. It allowed the pilot to switch over to a more direct routing to the generator, or what was termed 'emergency generator'. If one or both generators were intact and producing some amount of current, then this emergency 'bypass' system would allow you to tap into any AC power coming from them. This emergency mode was intended as a last resort in order to provide unregulated and reduced power for running certain critical components necessary for flight. In the case of a non-rotating or seized generator, then no power would be available to power the boost pumps.

We were now operating on emergency generator power with sufficient AC current for fuel pump operation. We were still in the weather, flying formation off the tanker, but had dropped back near my visual limits with it. I reviewed our status with Keith. The RSO's cockpit didn't have a telelight panel, so I needed to keep Keith informed. I then told the tanker that our situation had gotten worse and we needed to get over land. It was hard to believe we had two totally independent failures; I was convinced there was a single failure at the route cause of all this.

I shifted my attention to what we had working, while the tanker continued the descent through the weather. Keith said he was in a totally dark cockpit with no lights, no INS information, no navigation and no radio control! I had a faint light on my airspeed and heading indicators, but the rest of my instrument panel was dark. I knew that under emergency power I was supposed to have boost pumps, cross-feed, CG and fuel indicators, together with pitch and yaw trim. I also knew

◀ Captains Larry Brown (left) and his RSO Keith Carter were another SR-71 crew to enjoy the hospitality of the Norwegian Air Force, after they were forced to divert '980 into Bodø on 20 October 1987. (USAF)

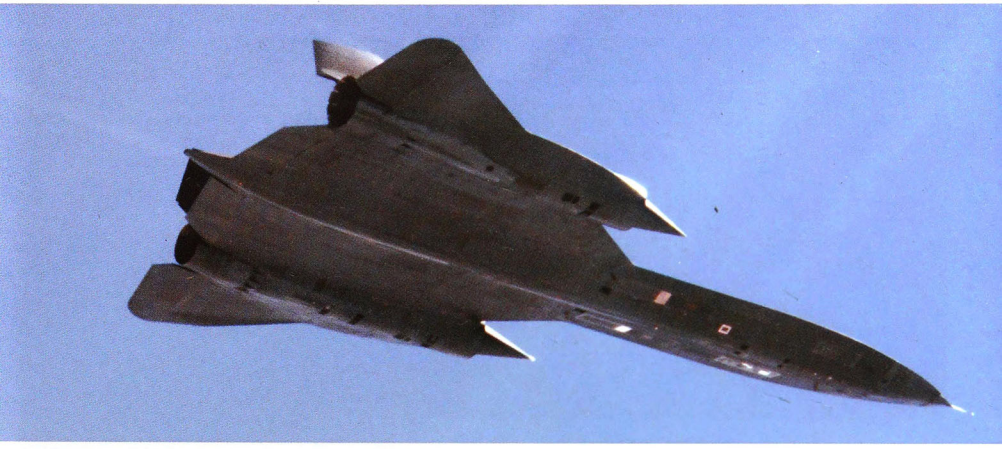
that my DC essential bus and the AC emergency bus (different from the back-up emergency AC system to run the boost pumps) were being powered by either the number one battery or one or both of the transformer rectifiers. With the emergency AC voltage high enough from the generators, then the transformer rectifiers would power the emergency AC and essential DC buses: if not, then they would only be powered by the number one battery, which would only last for a very limited time.

My VHF radio was another concern, as was the intercom for talking with Keith. Cross-checking my telelight panel I saw that the 'EMER BAT ON' status light was not illuminated, indicating I had good AC voltage from my emergency generators. Both transformer rectifier lights were also out, assuring me I had good DC voltage to run my essential DC bus. My instrument inverter light was ON, which was supposed to be the case for this condition. These status lights indicated the electrical system was operating as designed while under emergency power. I could now see that the tanker had increased the descent rate and was still in an orbit, but I couldn't see any coastal lights.

We had been operating under emergency AC power for about 3 minutes and things at least looked stable. It would just be a matter of picking up the coastal lights and then manoeuvring to final approach and landing. I was about to ask for our position and heading when the red master warning light illuminated again. This can't be good, I thought. Checking my telelight panel, I discovered the left generator fail light was on, indicating we had a complete loss of the left emergency AC back-up system, probably due to a seized generator. I made a call to the tanker that we were down to our last source of emergency AC power. ATC informed us that a rescue helicopter had been dispatched.

We went from a simple single generator failure to losing our nav and radios, then losing the right generator to losing the emergency left generator system. Out of four AC generator modes, we had lost three of them and were now down to our last one, and all within 15 minutes! There was no reason to believe that the remaining right generator would not completely fail. I still couldn't make out the coast, or for that matter a horizon. I asked for range and bearing to Bodø and ATC replied with 'on the nose for 25 miles'.

With the left generator completely gone, I knew I had lost half my tank 4 boost pumps. Pumps 4–2 and 4–3 were now without power, leaving me with just pumps



▲ This photograph was taken by a Swedish Air Force JA 37 Viggen pilot on 29 June 1987. During the course of an operational mission into the Baltic, Maj Duane Noll and his RSO Maj Tom Veltri suffered an explosion in the right engine of '964. Note the position of the nozzle on the shutdown engine and the rudders angled to compensate for the effects of asymmetric thrust from the left engine. (Swedish Air Force)

4–1 and 4–4, basically one pump for each engine. I wasn't sure of the voltage or current output of that remaining AC generator. If it was too low, then the boost pumps might not have sufficient AC power to meet fuel demands under the high engine power settings required during approach or go-around. The fuel cross-feed valve had been selected open, but there was no light to indicate that it was functioning. I selected tank 2, but there was no light to indicate that the pumps were operating.

Finally, I made out the surrounding lights of Bodø air base. I still could not read most of my indicators. I lowered the gear as soon as I was sure of making it to the coast. Thankfully, all three green gear down and locked indicator lights came on. I knew I didn't have a taxi light, but at least I retained control for deploying the drag 'chute. At about 10 miles from Bodø, I picked up the runway, cleared the tanker off and manoeuvred to about a 5-mile final. I wasn't sure of my exact speed, but kept it high in case I lost an engine. Over the overrun, I brought both throttles to idle, touching down about 1,500ft down the runway. With a good 'chute we came to a stop about 5,000ft down the runway. The time was about 20:50 local.

We radioed the tanker that we had landed safely and they in turn informed the tower; they couldn't see us since we had no exterior lights. After tuning to the tower frequency on VHF, we were able to communicate and coordinate our movement around the airfield. Keith and I were pretty glad to be on the ground! We taxied to a remote hangar, where we shut down and were greeted by an officer overseeing the operation. Now we were safely down, the security of the aircraft and the take was our priority.

▶ SR-71 61-7967 flares for landing at Mildenhall after completing a functional check flight on 20 November 1989, following termination of the Senior Crown programme. Note the panoramic nose section. (Bob Archer)

Norwegian military security personnel were soon on the scene, and they brought with them about a dozen very well armed guards. We instructed their officer in charge that no

one other than Keith or myself was allowed past them into the secure zone. They secured the perimeter with armed guards all in view of each other. Keith and I felt confident it was safe to leave the aircraft and its valuable intelligence cargo.

We were then transported to their command post, where we were patched through to our operations post at Mildenhall. We had a lengthy discussion with maintenance describing the extent of our problems. No doubt, they were at a loss as to what what systems could have failed to that extent, and what they needed to bring over with them. Afterwards we were given rooms at the officer's quarters, along with some 'flights' to wear and an invitation to join the base commander at his table for dinner.

The following day a KC-135Q arrived from Mildenhall carrying our maintenance and security personnel and, most importantly, our personal belongings. I always had a 'grab-and-go bag' with all the necessary clothing in my room, just in case of a landing away. I was also glad to see they'd included a generous amount of refreshments, which were very expensive in Bodø! We had an access list of all personnel allowed into the secure area, which Keith and I reviewed. We then coordinated with the Norwegian officer in charge to transfer security over to our military security personnel. Keith and I were very grateful to our Norwegian friends, and we were certainly impressed with their ability to respond with such little notice and with such a high degree of professionalism. Every detail was covered, and we were treated with the utmost courtesy.

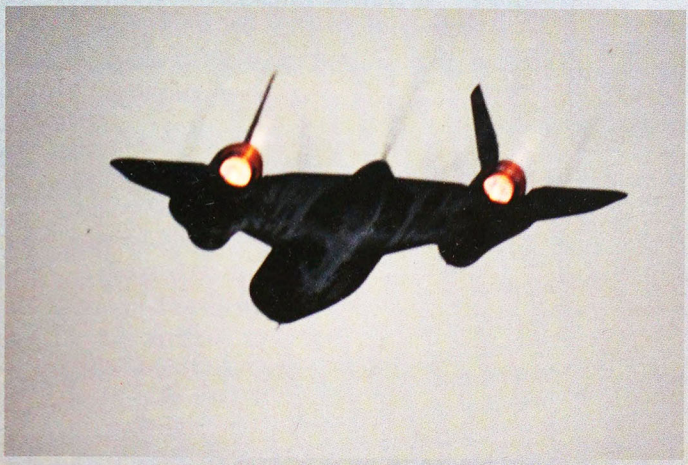
During the next four days of our stay, Keith and I went out to the hangar to check on progress and help out, including conducting engine runs. It looked like it was going to be ready for the flight back to Mildenhall on 24 October. I was hoping for a daylight departure, but system checks took a bit longer than anticipated, so we finally launched out of Bodø that evening for the night subsonic return to RAF Mildenhall. Although we had a little apprehension about the reliability of the electrical systems, the aircraft flew quite well with no abnormal occurrences. The aircraft was put right back on schedule after a few more checks, once again demonstrating what a superior ground crew we had; it was a real test of our capability.

During the tear down, maintenance discovered we had suffered two completely separate failures. The loss of the right generator was due to a failure of the right voltage regulator, while the loss of the left generator was due to a failure in the accessory drive unit. This failure of the left side caused the generator to seize and would have also resulted in complete left utility hydraulic failure. I guess it was fitting that on 18 January 1989, Keith and I flew our last SR-71 flight in aircraft '980!

▲ As detachment commander at the time, it fell to Lt Col Tom Henichek to reluctantly officiate at its deactivation. His obvious fatigue says much about the thoughts of the Habu community at the time. (Paul F. Crickmore)

▼ Lt Col Tom McCleary and his RSO Lt Col Stan Gudmundson arrive at the barn and make a beeline for the team of ground technicians. to thank them and bid them farewell. (Paul F. Crickmore)

▶ On 18 January 1989, Tom rotates '964 off the Mildenhall runway for the last time. With the programme having been terminated six weeks earlier, it was a master stroke calculated to catch the Soviets off-guard, sending the aircraft home via an operational sortie into the Barents Sea. (Paul F. Crickmore).



◀ Majors Don Watkins and his RSO Bob Fowlkes flew '967, the last SR-71 to leave the UK, home to Beale on 19 January 1989. The weather was in keeping with the event, cold and grey. (Paul F. Crickmore)

CHAPTER 13

LIQUID
NITROGEN
KEEP FREE FROM
OIL & GREASE
LIQUID
NITROGEN
KEEP FREE FROM
OIL & GREASE

SQUARING UP OVER THE BARENTS SEA

From Chapter 12, it's apparent how important SR-71 intelligence-gathering operations into the Barents Sea were, particularly for the US Navy. From a Soviet perspective, it's equally apparent how important the defence of this 'bastion' was to Soviet naval strategy. In this chapter, a retired Soviet MiG-31 pilot, Major Mikhail Myagkiy, recalls techniques used during practice intercept attempts on Habus participating in PAROP missions to the area. Retired Lt Col Ed Yeilding and his RSO Lt Col Curt Osterheld also relive missions over this frozen hot-bed of military activity as these opposing forces squared up to one another.

In 1972, the Mikoyan OKB began working on a new design destined to replace the MiG-25 interceptors. Designed around two D-30F-6 afterburning turbofans, the aircraft would have both a lower top speed and ceiling than the MiG-25PD: however, this fourth generation interceptor, equipped with a weapons-control system based on the SBI-16 Zaslon (ASCC "Flash Dance") phased-array radar, enabled its two crewmembers to intercept and destroy targets in either the front or rear hemisphere, day or night, in any weather conditions and while operating in a passive or an active jamming environment and flying at high supersonic speeds. Designated the MiG-31, the type's final Act of Acceptance was signed in December 1981 and deliveries to PVO units began in 1982.

◀ Readying an SR-71 for a mission began many hours before the crew arrived at the aircraft. Here a technician fills the aircraft's three liquid nitrogen dewar flasks. (Lockheed Martin).

Like the MiG-25PD before it, the new MiG also had a full infrared search and track capability; located in a retractable pod, the STP IRST enabled the aircraft to execute attacks without recourse to its radar. Typical armament consisted of four R-33 long-range air-to-air missiles carried semi-recessed in the fuselage on AKU-410 ejector racks, or four R-60M missiles if the target was to be engaged using the IRST. Each R-33 missile weighed 1,058lb, including its 103lb HE/fragmentation warhead and had a range of 75 miles. The new Zaslon radar touted a detection range of 180km (111 miles) and a target tracking range of 120km (75 miles). The aircraft's avionics suite also included the BAN-75 command link, the SAU-155M automatic flight control system, the APD-518 digital secure data link system (this enabled a flight of four MiG-31s to swap data generated by their radars provided that they were within 200km (124 miles) of one another), the RK-RLDN secure data link and the SPO-15SL Radar Homing And Warning System (RHAWS). A highly capable navigation suite enabled the MiG-31's crew to operate confidently in the Arctic theatre of operations.

By late 1980, the flight test programme had been successfully completed, and the first MiG-31 production aircraft had been delivered to PVO units and had achieved initial operating capability. The major units to be equipped with the type were the 153rd IAP (Istrebeetel'nyy Aviapolk – fighter regiment) stationed at Morshansk, the 786th IAP at Pravdinsk, the 180th IAP at Gromovo, the 174th IAP at Monchegorsk, the 72nd IAP at Amderma and the 518th IAP at Talagi.

Russian military aviation writer Valery Romanenko has undertaken detailed research for this book, and with the help of translators James F. Gebhardt, Ilya Grinberg and Dr Heinz Berger, the fruits of an interview with Maj Mikhail Myagkiy are detailed below.

Military 1st Class Pilot Mikhail Myagkiy, Guards Major (ret.), is one of the PVO (Protivo-vozdushnoy Ororony or air defence force) pilots who executed intercepts of the SR-71 near the border of USSR in the far north. Between 1984 and 1987, he was a Mikoyan MiG-31 'Foxhound' commander with the 174th Gvardeiskaya Istrebeitel'nyi Aviatsionnyi Polk (GvIAP, Guards Fighter Aviation Regiment). During this period he conducted 14 successful SR-71 intercepts.

Myagkiy graduated from Armavir VVAKUL PVO (Higher Military Aviation Red Banner Academy of Pilots of the PVO) in 1977. He started his front-line service on the Sukhoi Su-9 "Fishpot". He then qualified as a 1st Class Pilot on the Mikoyan-Gurevich MiG-23ML 'Flogger G', having accumulated approximately 600 hours of total flying time. At that time he held the rank of captain.

In 1983, only two regiments flew the MiG-31. The 786th IAP at Pravdinsk (near Gorkiy) was the first of these units, followed by the 174th GvIAP at Monchegorsk (near Murmansk). Before operating the MiG-31, the 174th GvIAP flew the Yakovlev Yak-28P 'Firebar'. During the transition to the MiG-31, many pilots left the unit – apparently they did not want to master the new aircraft. The majority of the remaining 174th trainees were weapon systems operators (WSOs). Therefore pilots had to be selected from other regiments because at that time only 1st Class Pilots were being selected to fly the MiG-31.

Consequently, the PVO's 14th Air Army was required to supply one pilot. At that time Captain Myagkiy was acting as a flight commander. Transfer onto the MiG-31 meant a reduction in position, since the air army commander did not release pilots from their permanent duty positions, but allowed transfer to temporary positions.

Myagkiy arrived at the 174th GvIAP in October 1983. The regiment had already been flying the MiG-31 for 18 months and had frequently flown missions against the SR-71.

After a month, Myagkiy was sent for transition training to the Tsentry Boyevoy Podgotovki, IA-PVO (TsBP IA-PVO, centre for combat readiness, PVO fighter aviation) in Savasleyka. The MiG-31 WSOs, with two of whom Myagkiy would later fly, also underwent

transition training at Savasleyka.

Only conversion training onto type was taught at Savasleyka. Over the course of two months, the pilots studied two aircraft: the MiG-31 and the MiG-25PU 'Foxbat C' (the students took a separate examination on each aircraft). Initially, they flew the dual-control MiG-25PU two-seater trainers. Four flights were conducted in the MiG-25PU, and the fifth, sixth, and seventh flights in the MiG-31 (with an instructor). On the eighth MiG-31 flight, the pilots went solo (with a WSO in the back seat rather than an instructor). After this, training was solely on the MiG-31.

The flight-training programme was very short. On 21 May 1984, Captain Myagkiy received his authorization for independent flights in the MiG-31, and on 21 June 1984 he received his authorization for combat readiness. This meant that he could now fly and conduct a combat patrol in daytime and in bad weather. By the end of July, the captain was carrying out combat patrols.

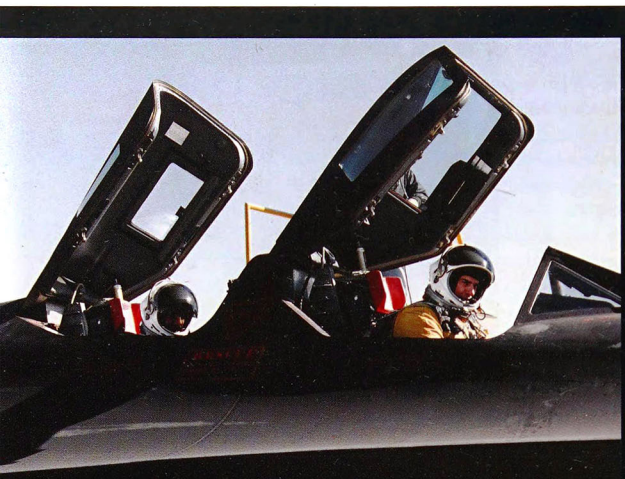
▲ Majors Ed Yeilding (left) and his RSO Curt Osterheld are driven out to their waiting aircraft in the PSD van. Major Doug Soifer (centre) is one of two members of the mobile crew that would have conducted the aircraft's walk-around inspection prior to the crews' arrival at the 'barn'. Ed remarked, 'Occasionally, upon arriving at the aircraft and discovering a long, unexpected maintenance delay, it was good to have a comfortable recliner to relax in before a long mission in the heavy pressure suit'. (Ed Yeilding)

Mikhail Myagkiy executed his first mission against the SR-71 from a combat readiness posture on 21 August 1984. According to his recollection, the procedures for a successful intercept were crazy and completely inadequate when considered against the threat posed by the SR-71's spy flights. The speed and altitude of the American aircraft simply hypnotized everyone. Therefore, each attempted SR-71 interception was considered a top priority, not only for fighter aviation but also for the PVO's entire 10th Army. The ground vectoring station on Rybachiy Peninsula typically made the first 'sighting'. Intercepting aircraft then took off from all the airfields in the north where weather permitted. A mistake at any level – by a pilot, the ground personnel, a command post, or a ground vectoring station – brought with it the threat of a military tribunal (court martial).

Each fighter regiment executed an intercept in its own sector. For the 174th GvIAP, this was the sector of the Soviet border from Kharlovka to Cape Svyatoy Nos. For the unit's MiG-31 crews, 16 minutes elapsed from the moment the alert was sounded to the take-off command being given. Of this time, two minutes were used to put on the VKK-3 (*vysotnyy kompensiruyushchiy kostyum*, or altitude-compensating suit), two minutes to run 50 to 60m (55 to 66 yards) in the VKK and get strapped into the aircraft, and the remainder of the time to check out the systems, start engines, and taxi. After 16 minutes the fighter would be parked at the end of the runway, with its engines running, fully prepared for take-off.

When the SR-71 alert was first given, the technical personnel ran to the aircraft and initially removed its R-60 (AA-8 'Aphid') short-range missiles because they would be disabled at velocities above Mach 1.75 (the standard MiG-31 ordnance load included four R-60s and four long-range R-33s (AA-9 'Amos')). Before the aircraft was launched, its inertial navigation system (INS) had to be activated in minimum time. As soon as the green lights confirming that the INS was aligned came on (after approximately 3 minutes), the engines could be fired up.

The two crews of the ready flight prepared immediately. Everything was accomplished in a somewhat tense environment: since these aircraft were from first production series, there were occasions of system failure, particularly during the turning off of ground power. If the ground power plug was pulled out too abruptly, the INS system malfunctioned. The crew that managed to reach full readiness first was the crew that launched.



▲ Ed and Curt work through the challenge and response check-list prior to engine start. (Ed Yeilding)

Having received permission to taxi, the aircraft took up a position at the end of the runway. Here, the crews sometimes had to 'cool their jets' for several minutes. The scheme for intercepting the SR-71 was computed down to the second, and therefore the MiGs had to launch exactly 16 minutes after the initial alert. During this period of time the ground vectoring station determined what route (out route or return route) the SR-71 was following.

Five minutes after take-off, the MiG was already at an altitude of 16000m (52,493ft). The afterburners would still be lit and the crew experiencing significant g. In addition, the MiG-31 had a disconcerting idiosyncrasy – at high supersonic speeds (above Mach 2.35), the control stick moved all the way forward, pushing up against the instrument panel. The pilot had to extend his arm fully, which was very uncomfortable and quickly caused fatigue. However, the MiG-31 was significantly more benign in its flight characteristics at supersonic speeds than the MiG-25. The great weight of the MiG-31's on-board equipment and systems had an effect on its performance compared to the 'Foxbat', but its instrumentation was significantly greater and a generation more modern.

During an SR-71 intercept, many commonly accepted practices were broken. For example, take-off was executed in a northerly direction, while normal procedure called for a take-off to the south. A number of limitations were also removed: for example, the altitude for transition to supersonic flight was established as 11,000m (36,089ft), but during SR-71 intercepts Soviet aircraft were permitted to pass through the sound barrier at 8,000m (26,247ft). Ground vectoring was usually conducted at an altitude of 16,000m (52,493ft), but during an attack the MiG-31s reached 18,500–19,500m (60,696–63,976ft) (aiming to establish the best missile launch trajectory, the MiGs gained as much altitude as they could, right up to 20,000m (65,617ft)).

Information about the Blackbird normally arrived at the command post when the spyplane was three hours out (this information coming from a radio intercept station). As the SR-71s flew out of Mildenhall, conversations between their crews and those of their supporting tankers were 'captured' during inflight refuelling, so if tankers showed up, the IA-PVO waited for the SR-71.

◀ Once the compressed air system began to spool the engine up, the pilot moved the applicable throttle forward to the IDLE position, checked for immediate fuel-flow increase on the fuel-flow gauge: ignition occurred within 20 seconds as the TEB lit the fuel – as seen on the ground from the emerald-green flash. (Paul F. Crickmore)

▲ Lined up with wheels choked and brakes tightly on, each engine had to undergo an EGT check, one engine at a time, before take-off. (Curt Osterheld)

The standard SR-71 route was normally loop-shaped. If the spyplane appeared from the direction of Norway, it tracked toward the White Sea, farther to the north toward Novaya Zemlya, then turned around on a reverse course to the west over the Arctic Ocean. This track was called a 'straight loop'. If it initially flew from the direction of the Arctic Ocean toward Novaya Zemlya, then south toward the White Sea, then to the west along the coast of the USSR toward Norway, its track was called the 'return loop'. The tactics of the intercept were geared toward the type of loop the spyplane was flying.

The SR-71 was intercepted using only a thermal channel (infrared, IR). The massive IR emissions of its engines permitted it to be detected at a distance of 100–120km (62–75 miles). The MiG-31's thermal detection system was called OMB (or optical multifunctional apparatus) and was mounted in the lower nose of the aircraft. The device was lowered and turned on by the WSO. The MiG's radar was not turned on. On combat alert the radar was set on a combat frequency, and in order not to expose this frequency to a 'probable enemy', the radar was not turned on. A passive system (the thermal apparatus) was adequate for a reliable intercept.

After capture of the target by the OMB, a target indicator showing the range to the target appeared on the *sistema edinoy indikatsii* (SEI, unified display system) in the pilot's head up display (HUD). A voice indicator, using a pleasant female voice (known as 'Rita' to the crews), announced 'Attack!'. The range to the target was calculated by the aircraft's BTsVM (on-board digital computer), using a triangulation method that employed other on-board sensors. This was very good, because, for example, on the MiG-25 the pilot did not receive range to target data as it was only passed from ground vectoring stations. Also, the ZDR (or zone of range of missiles, basically the engagement envelope for the missiles) was projected on the HUD.

After the 'Attack!' signal, missile preparation began. Targeting instructions were handed off to the *golovka samonavedeniya* (GSN, the missile seeker head). Four green triangles appeared on the image of the MiG in the cockpit display after the missiles had been prepared for launch.

The *bortovaya radiolokatsionnaya stantsiya* (BRLS, on-board radar) was turned on only in the event that the vectoring station issued an order to destroy the target. In this case, the WSO

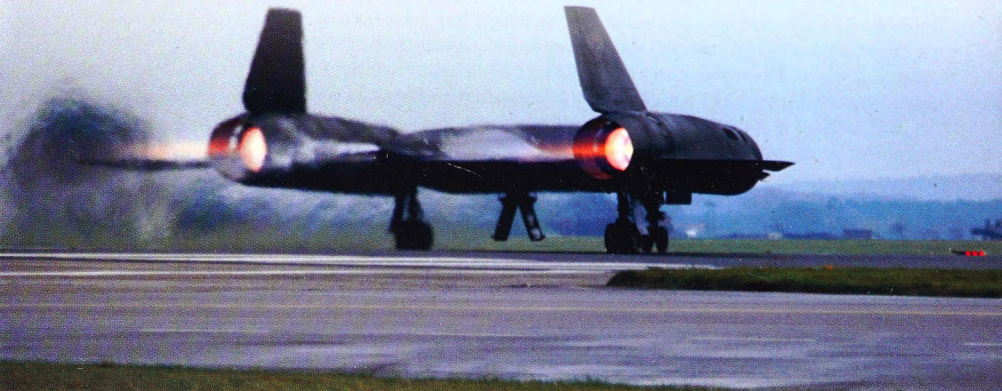
would turn the radar on. Information regarding the target would then be instantly transferred from the OMB to the radar. After this the pilot had only to push the firing button and the missiles would be launched.

If the SR-71 had violated Soviet airspace, a live missile launch would have been carried out. There was practically no chance that the aircraft could avoid an R-33. But in the early 1980s the Blackbirds did not violate the border, although they sometimes 'tickled' it (came right up to it). Indeed, local counter-intelligence dreamt of finding pieces of the SR-71, if not on land then in the territorial waters of the USSR.

Mikhail Myagkiy particularly remembers his eighth intercept, when he managed to gain visual contact with an SR-71, and not just in the form of a spot on a screen. As a keepsake he preserved the printout of the recording from the 'black box' through which all the intercept data was processed. Here is how he describes that flight:

> I went on combat alert on 31 January 1986 as normal. I drew my personal weapon in the morning and then headed for the on-duty crew hut.
>
> They alerted us for an SR-71 intercept at approximately 11:00. They sounded the alarm with a shrill bell and then confirmed it with a loudspeaker. To this day I have been averse even to ordinary school bells, because a bell was the first signal for a burst of adrenaline. The appearance of an SR-71 was always accompanied by nervousness. Everyone began to talk in frenzied voices, to scurry about, and react to the situation with excessive emotion.
>
> I ran to put on my VKK and GSh-6 [*germoshlem*, flight helmet], and over that a fur-lined flight jacket with IPS [*individualnaya podvesnaya systema*, parachute harness], and ran the 60m [55 yards] to the aircraft. I was not flying with my own WSO, but with Aleksey Parshin, our flight WSO. When I sat down and was being strapped in (it was simple and convenient to be strapped in wearing a jacket and IPS, which is why we flew in them), the readiness lamps for the INS were lit. I pressed the engine start button, reported to the command post, and immediately received the command to taxi to the runway. We sat on the runway for about five minutes; my WSO 'read the prayer' [loudly went through the pre-takeoff checklist].
>
> After the take-off order from the command post we lit the afterburners and took off. Our take-off speed was approximately 360km/h [224mph]. Not coming off afterburners, we went for altitude with a 60° right bank and turned to a course of 100°. We attained 8,000m [26,247ft] and reached the horizontal area (for acceleration) in which we passed through the sound barrier. Here vectoring station 'Gremikha' had

▼ In full afterburner and generating 68,000lb of thrust, acceleration down the runway was fast and the Habu was usually airborne at 210 knots, 4,000ft down the runway on a 15°C day. (Paul F. Crickmore)



already assumed responsibility for vectoring us. Our indicated speed at this time was 1,190km/h [739mph]. We went for altitude again, up to 16,000m [52,493ft]. At 16,000m we were flying at Mach 2.3 and made a left turn to a combat course of 360°. The WSO lowered and turned on the OMB and within five seconds had captured the target. A feminine voice in the earphones announced, 'Attack!', and a symbol was illuminated on the SEI. The SR-71 was proceeding on the 'return loop', from east to west, so we began the intercept immediately.

As usual, we executed an 'aiming run' from 16,000m, gaining altitude to 18,900m [62,008ft]. After closing to 60km [37 miles] I spotted the contrail of the SR-71 on an intersecting course. I reported the heading to my WSO over the SPU [*samoletnoye peregovornoye ustroystvo*, intercom], 'I have visual!' A contrail at 22,000–23,000m [69,000–72,000ft] is very rare, but on this day the weather was excellent and the air was transparent, and the contrail was clearly visible. I passed under the spyplane: it was 3,000–4,000m [8,843–13,123ft] above us, and even managed to make out its black silhouette. The SR-71 was flying over the ocean ever so carefully on a track 60km [37 miles] out from, and parallel to, the coast. I reported 'we're breaking off' to the command post and came off afterburners. We had been airborne for 15 minutes 40 seconds.

The Blackbird was flying its normal route, over neutral waters, and it made no sense to follow it. Therefore the vectoring station gave the command to turn onto a course for our airfield. We dropped down to 15,000m [49,21ft], transitioned to horizontal flight, and engaged a stopwatch. This was the so-called 'area for canopy cooling'. During flight at speeds in excess of Mach 2, the skin, including the canopy, heated up to 800°C. Therefore it was necessary to cool it. Failure to do so might result in cracking or catastrophic failure during subsequent altitude reduction. Our speed remained in the order of Mach 1.6.

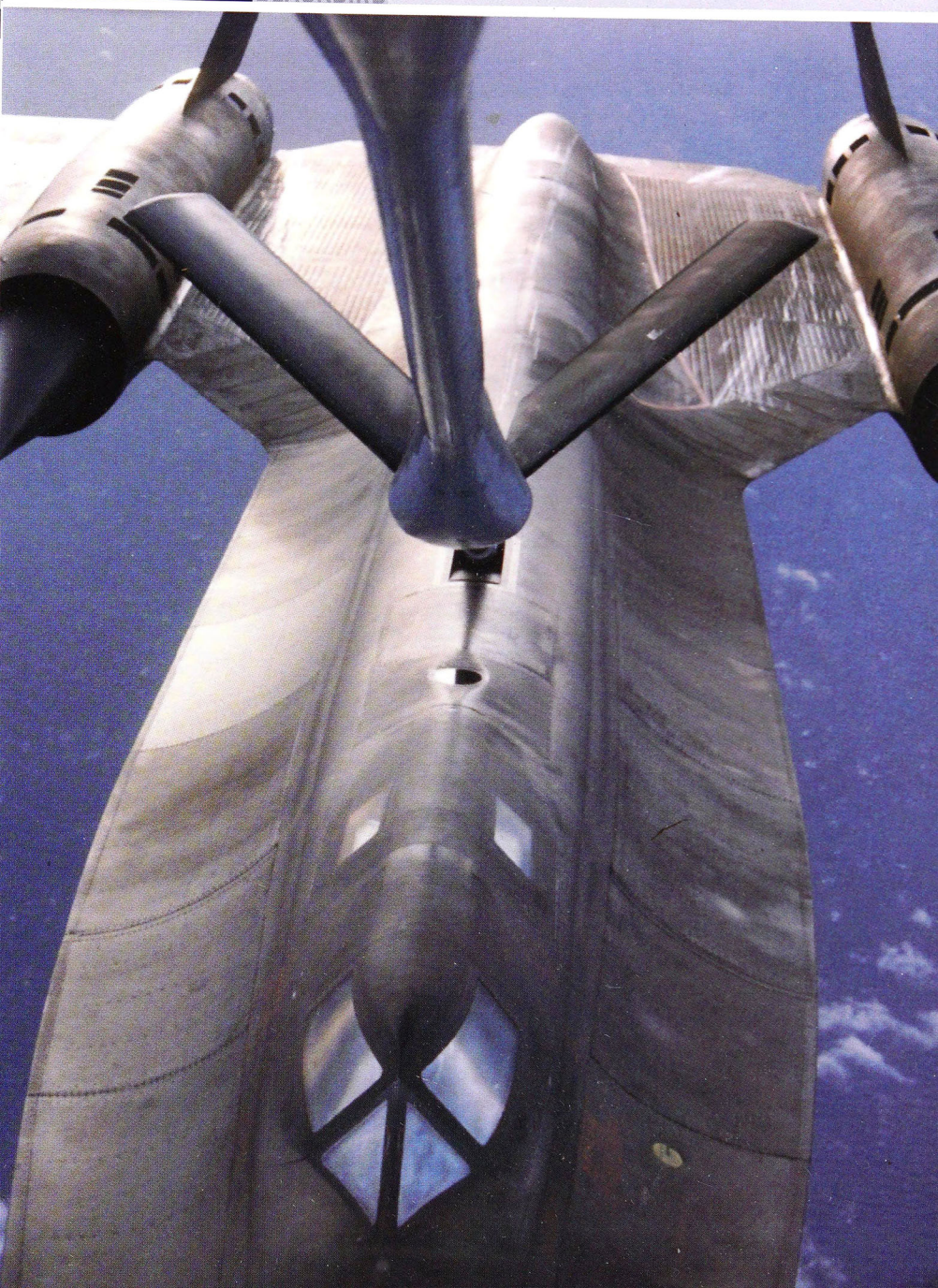
After 30 seconds we once again began to lose altitude. We went subsonic at the normal 12,000m [39,370ft]. Dropping down to 8,000m [26,247ft], we tracked toward our airfield. After the last vector was issued the command centre handed us off to our regiment command post, which directed me to a checkpoint at an altitude of 4,100m [13,451ft]. At 32km [20 miles] out from the airfield I lowered the gear and began to descend. We conducted a straight-in landing at a speed of 310km/h [193mph]. The entire flight had lasted 50 minutes.

During the 15 to 20 minutes when I was on a combat course, the second alert crew was sitting on the ground with engines running. Later they shut down their engines, but the pilot and WSO sat in their aircraft in readiness until our landing.

This was the only occasion in my 14 intercepts when I saw the SR-71 with my own eyes. It was obvious that a combination of circumstances facilitated this event: good weather that was rare in the north, clear air and unusual atmospheric conditions, when the contrail was clearly visible at an altitude of 23,000m [75,459ft].

Mikhail Myagkiy retired in 1992 with the rank of guards major at the age of 36. A review o his logbook reveals the following SR-71 intercepts:

21 August 1984
14 March 1985
18 March 1985
15 April 1985
17 July 1985



19 December 1985
20 January 1986
31 January 1986
21 February 1986
28 February 1986
1 April 1986
6 October 1986
23 December 1986
8 January 1987

◀ Shortly after take-off, the SR-71 was fully fuelled with JP-7 in order to purge the tanks of any air. As fuel burned off, the void was filled with gaseous nitrogen. Here '979 gets a top-off in the Goose Green refuelling track off the coast of Scotland. (Curt Osterheld)

According to Mikhail Myagkiy's logbook, he completed two practice intercepts on an SR-71 flown by Ed Yeilding. Ed now talks about some of his experiences while flying these vital missions.

The purpose of our Barents Sea reconnaissance missions was to gather intelligence as we flew just outside the territorial waters of the Soviet Union in the area of Murmansk, Russia and toward the Kanin Peninsula of Russia. We took great pride in these reconnaissance missions and believed our missions were an important contribution to the defence posture of the free world. During the Cold War, we knew the Soviet Union was potentially hostile toward the free world, and keeping close watch of their military facilities and activities was extremely important. We were given our routes of flight and target areas for our cameras and sensors, but we were not briefed on what our intelligence agencies were interested in along this area of Russia. I imagined that imagery of submarine ports, submarines, and the nuclear missiles being loaded on their submarines would be of prime interest, since those nuclear missiles were programmed for targets in our USA and elsewhere in the free world. Also, the Blackbird recorded Soviet electromagnetic transmissions of various types along our track. Our SR-71 missions were of vital importance, and we took great care in performing our missions flawlessly and with good judgment in handling various systems failures that could occur.

Our Barents Sea missions were conducted from our Detachment 4 at RAF Mildenhall, England. We Habus thoroughly enjoyed our periodic six-week assignments to Mildenhall, from where we flew missions not only to the Barents but to other areas as well. The flying was interesting and satisfying, and the British were friendly, supportive, and seemed to appreciate having us there. In our spare time, we greatly enjoyed seeing nearby sights and experiencing life in Great Britain.

For a typical Barents Sea mission, we departed Mildenhall half loaded with fuel for take-off safety, and within minutes we joined a KC-135Q, also from Beale AFB. The KC-135Qs always did an excellent job. Our rendezvous were at 25,000ft. Our UHF radios were encrypted with the classified code of the day and gave us automatic range and bearing for the join up without voice transmissions. Once joined and taking fuel, we were able to talk to the tanker crew through our interphone.

Air refuelling was challenging, especially in heavy turbulence, and we took pride in doing it well. Approaching full tanks, we were always 'behind the power curve' at that weight and slow speed, so it was necessary to finish the refuelling with asymmetric thrust, one engine in minimum afterburner and staying in position with throttle movements of the other engine at less than military power. Approaching full, the RSO skilfully had the tanker adjust the rate of transfer so that we were totally full with an automatic pressure disconnect at exactly our planned start climb and acceleration point.

▲ With full tanks, Ed lit both burners, accelerated and climbed away from the tanker to undertake a 'dipsy' manoeuvre before beginning the climb to 71,000ft and acceleration to Mach 3. (B. C. Thomas)

With full tanks, our flight manual recommended 'the climb-and-descent procedure' as the most fuel-efficient way to intercept the supersonic climb schedule. Most crews simply called it the 'dipsy'. Simply stated, we climbed at Mach 0.9 to 33,000ft and gently nosed over with maximum thrust. In the descent, the acceleration hesitated approaching Mach 1, then suddenly increased beyond Mach 1, as the altimeter momentarily fluctuated about 1,500ft as the shock wave passed over the static ports. Because the Blackbird was designed for supersonic flight, there was no vibration or other sensation of becoming supersonic. Even though supersonic, we could still hear the engines because engine sound was transmitted through the frame to the cockpit and not excessively loud. Stopping the descent near 30,000ft, I liked to glance through the periscope at our 'dipsy' contrail which looked like a roller coaster.

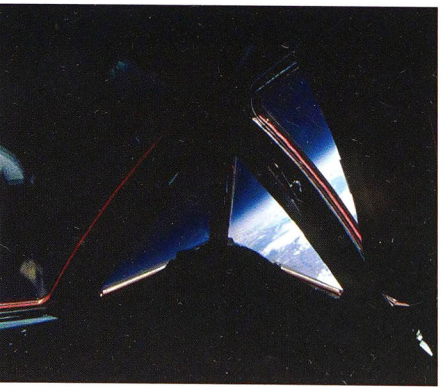
We climbed north and accelerated to Mach 3.0 and 71,000ft. Off the north-west coast of Norway, we descended to meet our second set of KC-135Q tankers in a refuelling track unofficially called 'Viking North'. After refuelling, we again climbed north, paralleling the coast of Norway, rounded the northern tip of Norway near 72° north latitude, well above the Arctic Circle, and soon again reached Mach 3.0 and 71,000ft, now heading east into the Barents Sea.

We flew a slow cruise climb of about 130ft per minute because we became more fuel efficient at higher altitudes as aircraft weight became lighter with decreasing fuel. The Blackbird was designed for best fuel economy at Mach 3.2, but our Barents missions were planned at Mach 3.0 and 32° of bank to aid in handling unstarts, manual inlet situations, and higher than forecast temperatures if any of those happened.

Mach 3.0 is about 1,980mph (1,721kt) at -56.5°C, the standard temperature of the stratospheric air in which the Blackbird flew. (The speed of sound in air is only proportional to the square root of air temperature in Kelvin and surprisingly does not vary with air pressure or density.) At 1,980 mph, 32° of bank gives a turn radius of 80.8 miles (70.2nm), so that a 90° turn took about 3.8 minutes to complete.

We always had the autopilot engaged in the reconnaissance area because it held a steadier platform for our cameras and sensors. The autopilot held constant pitch attitude, so I made climb rate and altitude adjustments with the autopilot pitch wheel on the right console. I maintained precise airspeed with smooth throttle inputs. We did not have auto throttles keeping exact speed, as many modern aircraft have today.

▼ The forward view from the pilot's cockpit of an SR-71 with the sun-shade on the right. At 80,000ft, the horizon could be seen 350 miles away. (B. C. Thomas)

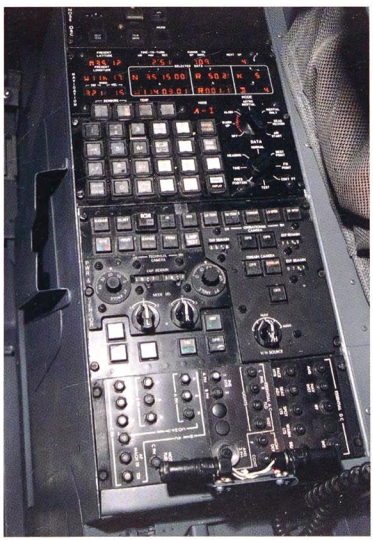


The autopilot flew the planned track with imperceptible small roll inputs, guided by the astro-inertial navigation system, ANS. The track and sensor action points were loaded as a spool of magnetic tape into the Blackbird before flight, and the autopilot followed the magnetic tape track amazingly well. During rare failures of the autopilot, I could precisely fly the track by keeping the course deviation indicator (CDI) centred with gentle roll inputs with the flight control stick. In those years before GPS navigation, I was amazed that the Blackbird had a small telescope, under glass behind the RSO, automatically tracking stars and updating the ANS inertial position, because our flights were often outside the range of reliable ground navigation transmitters.

Barents Sea missions were especially interesting because the Barents Sea is above the Arctic Circle. I will never forget my very first entry into the Barents Sea area. RSO Steve Lee and I had completed our very challenging but very satisfying SR-71 training in the summer of 1984, a dream come true for both of us! That fall, we had our first operational experience at Okinawa, and now on 10 Dec 1984, we were on our very first Mildenhall mission, a mission to the Barents Sea. There we were, just starting our cruise at Mach 3.0, 71,000ft and had just rounded the northern tip of Norway near 72° north latitude, flying toward the east. I was full of anticipation, as we were just minutes from beginning our very first reconnaissance pass along Russia's northern coast.

▲ Curt takes a photograph of himself at 'the office'... over 70,000ft high. (Curt Osterheld)

In the eerie December twilight, I happened to look about 90° to my left, and was very surprised to see a nearly full moon had risen and was sitting there just above the horizon! Having always lived at low latitudes, I knew the moon always rose approximately in the east. Suddenly, I had deep concern as I thought, 'Is east over there? If so, we're flying south, straight into Russia!' My magnetic compass was within 15° of my heading indicator ,which I was very glad to see. Just to be sure, I asked Steve if he still had a 'star light'. He did, which meant our ANS was happily tracking stars and navigating accurately. I immediately realized the moon was in an unusual spot because of our high latitude, and I then resumed total concentration on flying the Blackbird. Our first mission went very well. Only after our mission, did I take time to reason that in December, the earth's northern axis is tilted away from the sun and tilted toward an almost full moon. The earth's tilt, combined with our high altitude at that high latitude, had allowed me to look over the top of earth and see the moon on the other side. Seeing the newly risen moon sitting just above the northern horizon near the North Pole had caught me by surprise and caused me an anxious moment during my very first entry to the Barents Sea.



◀ The RSO's right console contains controls for the OBC (when configured: at the top of the page). Next is the ANS display followed by controls for the ground mapping radar and technical camera. The last area of the panel contains various circuit breakers. (Curt Osterheld)

On winter days in the arctic, the day/night line, called the terminator, runs almost east-west at noontime. Even though the Barents Sea is entirely above the Arctic Circle, we could often see the sun, low on the horizon, even in late December, due to our high altitude. The Blackbird mission track might cross the terminator several times, causing the

crew to see a sunset or sunrise each time. On those missions, our primary sensor was usually the Advanced Synthetic Aperture Radar System, ASARS, which could obtain imagery day or night. I once had a mission track in late December that surprisingly crossed the terminator six times, so in the space of just an hour, we'd seen three sunsets and three sunrises!

With the Soviet Union just to the south, flying at the far east end of the Barents Sea was foreboding, especially daunting in the dim twilight of winter, with over 600 miles of sea ice and icebergs between us and our friendly tankers waiting at 'Viking South', off the north-west coast of Norway. If something happened to our Blackbird that required ejection, I was not confident that we could survive long enough with our small, one-man life rafts to be found and rescued from the hostile, windy, frigid Barents Sea. Thanks to outstanding Blackbird maintenance, excellent training, leadership, and good fortune, no Blackbird was ever lost in the Barents Sea, nor was any Blackbird ever lost during Mildenhall Det 4 operations.

After about three weeks of Mildenhall flight experience, possibly 31 Dec 1984, RSO Steve Lee and I had a malfunction that caused us some concern. There we were, Mach 3.0, about a quarter of the way through our Barents Sea reconnaissance track, and our cockpits started to overheat. I usually kept our cockpits at about 68°. I turned the cockpit temperature control full cold and checked my pressure suit heat off. Cockpit temperature continued climbing through 80°. I called for the cockpit overtemp checklist, which we worked our way through slowly while Steve continued his reconnaissance duties. The checklist calls for a number of switch actions with several waits to see effectiveness. We also had several circuit breaker pulls and resets that we had pencilled in during training. Now, we were at the far east and most foreboding end of our Barents Sea track and the temperature was rising through 110°. We were uncomfortable, but the warm very dry air circulating in our pressure suits helped us lose heat, evaporating moisture through our skin. We felt we could continue on track and get the pictures, at least for the time being.

I was pretty concerned because I did not know how much hotter the cockpit would get. I knew air friction caused the aircraft skin to be around 550°F. Touching the cockpit windows with our pressure suit gloves was like touching an oven window. I thought how ironic it would be to die of heat stroke when ice was all I could see for hundreds of miles. I knew that if we started to get dangerously hot, I could turn north-west, getting more distance from Russia, while descending. At 25,000ft, Steve could then accomplish the last step in the checklist, 'Cockpit air – OFF (forward)', which would stop the inflow of hot air, but would depressurize the cockpit, which is why we would not do that step at cruise altitude. I knew it would take about 10 minutes to descend, so I would need to make that decision well before becoming dangerously hot. Fortunately, the temperature stabilized at 122°. We were uncomfortable, but the warm, very dry air circulating in our suits kept us functional. Steve told me his grease pencil, which he used for notes, had melted. When I opened my checklist, the plastic pages curled up. We were able to stay on track, though, and got all our pictures.

Steve had done an outstanding job, working in the heat, accomplishing all his reconnaissance duties while alternating reading overtemp checklist items to me. I remember, too, air refuelling in 'Viking South' on the way home. The stick was too hot to hold firmly, as I always did during refuelling. That time I had to use fingertip control while alternating fingers. With the cockpit air off, the temperature dropped to 85°, but after refuelling, we turned the cockpit air on again to pressurize the cockpit for a climb and cruise home at the lower altitude of Mach 2.4 in case we needed to descend

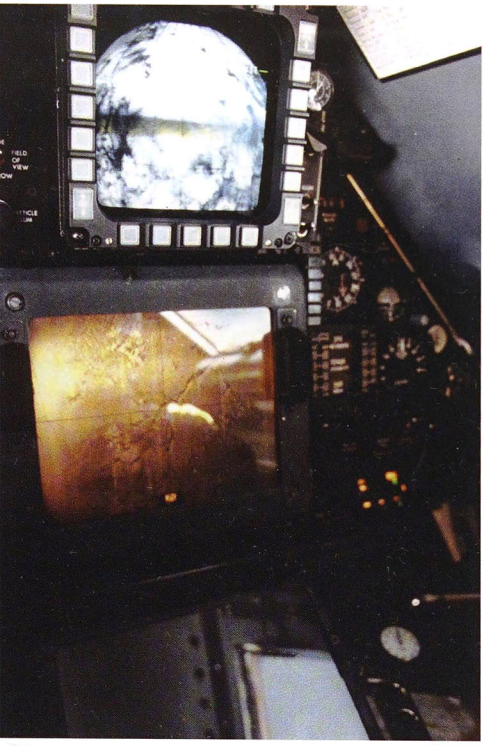
▲ Although the MiG-31 cannot match the MiG-25 in terms of outright speed, the 'Foxhound' is a much more capable interceptor. Note 'Red 57' has extended the in-flight refuelling (IFR) probe. (Yefim Gordon)

quickly. Arriving at Mildenhall we were a couple of hot Habus, happy to be home. Thus ended an uncomfortable, but successful, mission over the frigid Barents Sea!

In the springtime, as the Barents Sea's ice started to break apart, I could look down and see where the big pieces had fit: like seeing a puzzle which had some pieces dislodged, you could see where the pieces belonged. In the Arctic at cruise altitude, temperature deviations were much larger than at mid latitudes. I remember seeing plus 15°C to minus 20°C from standard, causing significant variation in fuel burn rates. Colder temps enabled the Blackbird to climb faster and burn less fuel during cruise. I almost always flew max range altitude, but one very cold day in the Barents after exiting the reconnaissance area with RSO Steve Lee, I climbed our Blackbird up to the flight manual limit, 85,000ft, just so we could say we had been there. Higher altitude causes a decrease in knots equivalent airspeed [KEAS], and arriving at 85,000ft and Mach 3.2 we were also at the lower supersonic limit of 310 KEAS. Below that could cause an engine flame-out. After about a minute at 85,000ft, where we could see the horizon 357 miles away, we descended to meet our tankers at 'Viking South' off the north-west coast of Norway. That day, at the west end of the Barents, at 85,000ft, is the highest I have ever been, thanks to the amazing SR-71 Blackbird!

The colder than standard air of the Barents often caused the Blackbird to leave long contrails during cruise. Contrails, short for 'condensation trails', are caused by water in jet engine exhaust condensing and turning rapidly to ice crystals. Whether a jet will leave a long contrail is a function of air temperature, humidity, and air pressure or altitude. Jet contrails at lower latitudes are common between 25,000 and 40,000ft, but extremely rare at Blackbird cruise altitudes. However, in the Arctic region the Blackbird often left long, visible contrails, especially in winter. In addition to visible contrails, we were told that Soviet radars could sometimes detect us intermittently as we flew along their borders, even though the Blackbird was designed with some early stealth features.

Another of my Barents missions was especially memorable because we had an encounter with a Soviet MiG-31. Because most details of Blackbird flights were



▲ The RSO's view-sight display can be seen at the top of this photograph. The Advanced Synthetic Aperture Radar System II (ASARS I) display is located immediately below. The ASARS I system generated high-resolution radar imagery regardless of day, night or cloud conditions. (Curt Osterheld)

classified at that time, I made no notes about the encounter, so I cannot verify the date of the encounter. I am certain that RSO Curt Osterheld was with me at the time. Curt and I had only two tours together at Mildenhall, so the encounter was between 25 Aug 1986 and 8 Oct 1986, or between 14 Apr 1987 and 7 May 1987. (I don't remember why that second tour was only three weeks.) I think the encounter might have been the last flight of our first tour. My flight records show we had a 4.1-hour mission with Blackbird tail '980 on 6 Oct 1986.

On that memorable MiG-31 encounter mission, I was glad to be flying with Curt, an outstanding RSO admired by all, and, by the way, one of the most popular Habus. (As of this time of writing, he was our excellent master of ceremonies at our last three large Blackbird reunions.) About 30 years ago, there we were, 71,000ft, starting our Mach 3.0 reconnaissance track, heading east just outside the territorial waters of Russia's Murmansk area coastline. I knew Curt was very busy in the rear cockpit with his many duties monitoring and managing cameras, sensors, and navigation. I kept a constant crosscheck of the many indicators and controls in the front cockpit, watching carefully for potential system failures, and maintaining stable airspeed and the most efficient altitude for our weight.

After Curt and I completed our first pass flying south-east parallel to the Russian border, gathering imagery and electronic intelligence, our mission track turned us left about 90° and northwards, directly away from Russia over the Barents Sea. After the turn and perhaps another minute in that northerly direction, we turned 180°, and flew directly towards and perpendicular to the Russian coast.

Our altitude then was probably about 75,000ft. At that altitude, we could see the horizon 335 miles away and see the slight, but noticeable, curvature of the earth. The view was grand. Ahead were miles of Barents Sea and snow-covered Russia beyond. In the distance far ahead, at perhaps 100 miles, I could see a long, bright white Russian contrail flying directly toward us, but at a much lower altitude. I knew it must be a Soviet fighter, probably a MiG-31, then the newest Soviet supersonic interceptor. I raised my periscope and saw that we too were leaving a long contrail. I knew the fighter could see our contrail as easily as I could see his. Since we were flying a routine reconnaissance track that the Soviets had seen many times, I knew the fighter knew exactly where we would start our 90° right turn to parallel the coast in a westerly direction.

I imagined the Soviet fighter pilot was much like me, with a love of aviation and trying hard to be one of the very best. I also assumed he had orders to fire his missiles if I was late with my turn and slipped over Soviet territorial waters to within 12nm of Soviet land, and I assumed the pilot would like nothing better than an opportunity to fire his missiles at an SR-71 Blackbird. Just three years prior, on 1 September 1983, a

Soviet fighter shot down a Korean Air Lines 747 that accidentally crossed into Russian airspace north of Japan, killing all 269 aboard. Certainly, the SR-71 Blackbird would be a prized target.

I believed the Soviet fighter would not fire his missiles as long as we stayed on our usual track, but I also knew he or his ground controllers could mistake our position as being closer than we actually were. In the 1980s, we were not too concerned about missiles as long as we maintained our high altitude and high speed. (For an excellent justification for our 1980s confidence concerning missiles, see Col Rich Graham's book, *Flying the SR-71 Blackbird*, starting on page 153.) From my previous years of flying intercepts in the F-4 fighter, I knew the newer MiG-31 would still have difficulty manoeuvring to the required launch envelope even if he knew our exact flight path. Also, in the high altitude thin air, we believed that missile manoeuvrability, range, and proximity fuses were not adequate to bring down the Mach 3 Blackbird. For radar-guided missiles, our low radar reflectivity further decreased missile 'probability of kill', and we had a jamming capability for further assurance. I knew our contrail could help him visually put his piper on us for a heat-seeking missile 'lock-on'. We had no defences like flares against heat-seeking missiles, but again, we believed that missile 'probability of kill' was very low due to our high speed and altitude. I was determined to fly the track as planned and get the pictures.

▲ MiG-31 'Blue 36' is seen armed with its most common weapons complement of four R-33 long-range AAMs under its fuselage and four R-60M short-range AAMs, mounted in pairs on twin APU-60-2 racks under the wings. (Yefim Gordon)

Flying straight toward each other in our supersonic jets, I was reminded of two gallant medieval knights galloping full speed toward each other, only I did not have a weapon. For survival, Curt and I depended on accurate navigation to keep us just outside Soviet territorial waters to prevent a launch, and we depended on our superior speed and altitude in case missiles were launched.

◀ While stationed with the 174th GvIAP at Monchegorsk, Military 1st Class Pilot Major Mikhail Myagkiy (unknowingly at the time) completed 14 practice intercepts (PIs) against the SR-71. Two of these were against SR-71 980 flown by Major Ed Yeilding on 31 January and again on 6 October 1986. (Mikhail Myagkiy)

▶ Here an SR-71 is seen with a contrail at about 30,000ft and in a descent (no afterburners). It wasn't unusual for the Habu to contrail at 70,000ft+ with temperatures much colder than standard in the Barents area. (Ed Yeilding).

The fighter's contrail was holding constant altitude and was heading straight toward us, but far below, perhaps altitude 40,000ft I guessed. I imagined he might be accelerating for a possible steep climb toward our altitude. I watched our distance indicator count down to our turn point, decreasing a mile every two seconds. As always, I was prepared, if necessary, to start the turn manually with the autopilot roll wheel or with the flight control stick, but at our turn point, the autopilot automatically initiated our 90° turn to the right.

Our 90° turn toward the west was programmed for 32° of bank. In the turn, I kept close watch on my instrument panel as always, ready to handle any malfunction. During my instrument crosscheck, I turned my head frequently to watch the fighter's contrail and saw that he was in a very steep climbing turn toward us. Perhaps a minute into my turn, while turning my pressure suit helmet with my hands so that I could see behind, I saw the grey metal of the fighter, low at my left 7:30 position, at the top of his steeply climbing contrail. We were still in our right 32° banked turn, but I could see him, barely larger than a dot. I could not discern any identifying features like twin tails or distinctive shape. From my F-4 experience with intercepts and visual acuity, my best guess is that 8 miles was his closest approach. He appeared to run out of airspeed at the top of his contrail, at maybe 65,000ft or about 10,000ft below us. I saw his nose drop below the horizon and fall away. Curt and I stayed on course and got the pictures.

During my three years of flying overseas reconnaissance missions, I frequently saw contrails far below of potentially hostile fighters, but that day, above the Arctic Circle over the Barents Sea, was the only time I saw a Soviet fighter get close enough that I could actually see metal, though barely larger than a dot and only because our routine track was predictable. Back at Mildenhall, during our debriefing, our intelligence officer told us, with near certainty, that the interceptor was a MiG-31, the premier Soviet supersonic interceptor at that time.

Flying the Blackbird was exciting, and the friendships among crewmembers and Blackbird community were great. Best of all, during those Cold War years, we all felt we were performing a vital mission for our country and for the cause of freedom worldwide.

◀ The Barents Sea seen by Ed and Curt from 70,000ft+ was both outstandingly beautiful and foreboding. Note the slight curvature of the earth and dark sky overhead caused by cruising above 97 per cent of the air's molecules. (Ed Yeilding)

In the back seat with Ed on the 6 October 1986 intercept was Maj Curt Osterheld, who provides an insight into what it was like as an RSO.

My purpose here is to provide some observations about the SR-71 in general, as noted from my office that was 5ft behind Ed's.

Aeronautical engineers talk about the Blackbird as a 'system of systems'. I think of the aircraft as a series of miraculous technological innovations all flying in very close formation.

Much has been written about the engine/inlet combination that made it possible to convert a turbojet-powered vehicle into a quasi ram-jet that made prolonged Mach 3 cruising flight possible. But from my perspective, the astro-inertial navigation system (ANS) was equally astounding. To think that this system could guide the SR's flight path anywhere in the world without the assistance of a single terrestrial-based navigation aid was amazing. And please don't forget this was before the advent of GPS by many years. And while the ANS kept you on course (on the 'black line', if you will), it also provided the precise pointing data for the sensors. All this while you were moving at the muzzle velocity of a 30.06 rifle bullet.

In training, RSOs were taught to take a 'trust but verify' approach with the ANS. The simulator could provide great embarrassment if one became complacent about turn points and course maintenance. Getting lost at Mach 3 is difficult to recover from ... and/or explain to your instructor. But in 631 flying hours and 98 operational sorties, I never had a glitch with the real, live ANS.

One reason training and mission preparation was so critical is that each SR-71 had its own idiosyncrasies. Many of these were minor ... a difference in fuel flow here, a slightly higher hydraulic pressure there, and some leaked much more on the ground than others. (N.B. Leaking fuel seems to be a favourite topic when discussing the SR at forums or in museums. One of the differences in 'leak rate' was the integrity of the sealant inside the fuel tanks. Recall that the SR did not have internal fuel bladders. The heating and cooling cycles of supersonic flight took a toll on this material. Aircraft that

▲ Another mission successfully complete, Curt (left) and Ed's next stop is a post-flight briefing. They report a great feeling of satisfaction after each mission, having just flown the world's fastest jet and contributed to the defence of their country and that of the west. (Ed Yeilding)

▶ Depending upon the aircraft's weight, outside air temperature and pressure, the basic final approach speed of an SR-71 was 175 kt. (201mph). (Paul F. Crickmore)

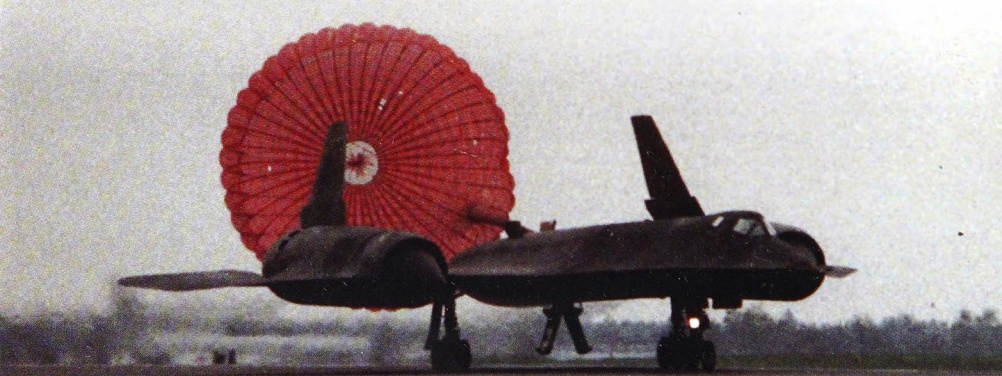
had just returned from Periodic Depot Maintenance (PDM) where this sealant was reapplied leaked far less than jets that had been in service for a while.)

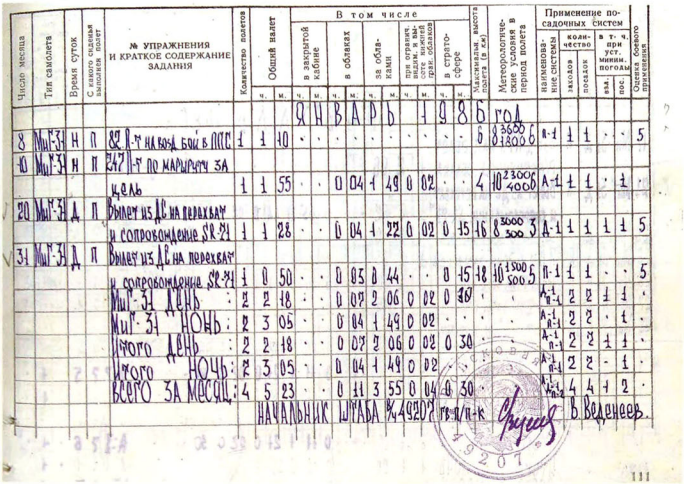
The biggest distinction between aircraft was their performance at Mach 3 cruise. Some were incredibly smooth ('971 was a Cadillac). Some acted like they did not want to go Mach 3 (I'm talking about you, '974!) Keeping the CG within the proper range was critical to safe and efficient flight. Some aircraft required a great deal of forward fuel transfer juggling. Others required very little. But the remarkable fact was that all these anomalies could be programmed into our simulator to keep the crews sharp.

The defensive systems (DEF Systems) of the SR-71 were largely automatic. You had an idea who/what was looking at you, but it was not as specific as, say, the ALR-46A, which we had in the RF-4C 'back in the day'. I confess 30 years has taken away any specific memories of DEF operations other than it was a 'set it and forget it' type proposition.

Ed's description of operations in the Barents Sea is perfect. We knew that the mission was strategically critical in keeping an eye on the Soviet ballistic missile submarine fleet. But we were also aware that if something went wrong with the airplane, the crew did not have many options. Given that we were operating under the rules of the Peacetime Aerial Reconnaissance Programme (PARPRO), our path was predictable and the Soviets used us for 'training' … both for surface to air missiles and fighter intercepts. I do have a very clear memory of turning westbound away from Novaya Zemlya (a.k.a. Banana Island). Looking out the right window and with the help of the mirrors, I could see we were pulling a fat contrail at 75,000ft. Looking down I could see a pair of circular contrails, which, I assumed, were Soviet fighters

▼ As soon as the SR-71's main gear touched down, the pilot pulled the T-handle that deployed the 40ft drag chute. (Curt Osterheld)





Число месяца	Тип самолета	Время суток	С какого сиденья выполнен полет	№ упражнения и краткое содержание задания	Количество полетов	Общий налет ч.	Общий налет м.	В том числе: в закрытой кабине ч.	в закрытой кабине м.	в облаках ч.	в облаках м.	за облаками ч.	за облаками м.	при огранич. видим. и высоте нижней гран. облаков ч.	при огранич. видим. и высоте нижней гран. облаков м.	в стратосфере ч.	в стратосфере м.	Максимальн. высота полета (в км)	Метеорологические условия в период полета	Применение посадочных систем: наименование системы	количество заходов	количество посадок	в т. ч. при уст. миним. погоды: вал.	в т. ч. при уст. миним. погоды: пос.	Оценка боевого применения
								Я	Н	В	А	Р	Ь		1	9	8	6	год						
8	МиГ-31	Н	П	82 Л-т на возд. бой в ППС	1	1	10	·	·	·	·	·	·	·	·	·	·	6	8 3600 / 1800 6	П-1	1	1	·	·	5
10	МиГ-31	Н	П	247 Л-т по маршруту за цель	1	1	55	·	·	0	04	1	49	0	02	·	·	4	10 2300 / 4000	А-1	1	1	·	1	·
20	МиГ-31	Д	П	Вылет из ДС на перехват и сопровождение SR-71	1	1	28	·	·	0	04	1	22	0	02	0	15	16	8 3000 / 300 3	А-1	1	1	1	1	5
31	МиГ-31	Д	П	Вылет из ДС на перехват и сопровождение SR-71	1	0	50	·	·	0	03	0	44	·	·	0	15	18	10 1500 / 500 5	П-1	1	1	·	·	5
				МиГ-31 День :	2	2	18	·	·	0	07	2	06	0	02	0	30	·	·	А-1 / П-1	2	2	1	1	·
				МиГ-31 Ночь :	2	3	05	·	·	0	04	1	49	0	02	·	·	·	·	А-1 / П-1	2	2	·	1	·
				Итого День :	2	2	18	·	·	0	07	2	06	0	02	0	30	·	·	А-1 / П-1	2	2	1	1	·
				Итого Ночь :	2	3	05	·	·	0	04	1	49	0	02	·	·	·	·	А-1 / П-1	2	2	-	1	·
				Всего за месяц :	4	5	23	·	·	0	11	3	55	0	04	0	30	·	·	А-1 / П-2	4	4	1	2	·
						Начальник		Штаба																	

В. Веденеев.

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◀ This page of Mikhail's log records two SR-71 PIs, on 20 and 31 January 1986. The second was flown by Majs Ed Yeilding and his RSO at that time Steve Lee. (Mikhail Myagkiy)

setting up for a 'practice' intercept. We believed that the only chance an interceptor (MiG-31) would have at a decent shot was a 'beak-to-beak' pass. I believed, like Ed, the velocity of closure and geometry of the required manoeuvre gave a very low PK (Probability of Kill) to this shot.

After we exited the 'sensitive area' it was time to start planning our descent for a refuelling off the coast of Norway. And here it is appropriate to salute our tanker brothers and sisters … none of this would have been possible without their teamwork.

Like Ed, I felt extremely honoured to serve our nation with so many outstanding Americans in the Blackbird programme.

If there is one regret I have about the SR-71 program, it's that I did not thank our maintenance folks often enough. The Blackbird was a very labour-intensive airplane, and these dedicated men and women kept it flying in all kinds of weather, all over the world. They are the real heroes.

▼ SR-71A 972 taxis back to one of the two purpose-built hangars at RAF Mildenhall. (Paul F. Crickmore).

CHAPTER 14

NASA

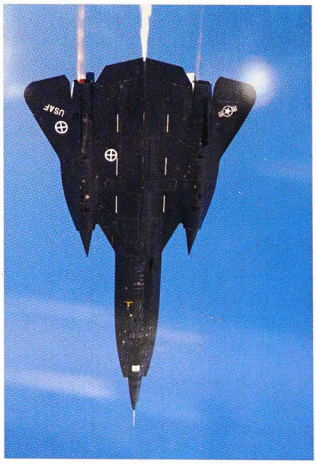
In 1967, the Ames Research Center of NASA negotiated with the US Air Force for access to early A-12 wind tunnel data. These tests had been conducted at Ames sometime earlier in conditions of utmost secrecy. The Air Force decided to release the information and in return NASA provided a small team of highly skilled engineers to work on the SR-71 flight-test programme. In the summer of 1967, a team from the Flight Research Center (FRC) under the leadership of Gene Matranga was engaged on various stability and control aspects of the SR-71 flight research effort at Edwards. This work helped to speed the SR-71 into the inventory and led to the establishment of a close working relationship between the Air Force and the NASA team.

◀ Among the final NASA SR-71 flights were those associated with the LASRE programme. In the event, the LASRE aerospike was never fired in flight, since insurmountable problems with fuel leaks made this too hazardous. (NASA)

▲ The first NASA flight test team standing in front of YF-12A 60-6935 are (left to right) Ray Young, Fitzhugh Fulton, Donald Mallick and Victor Horton. (NASA)

The Office of Advanced Research Technology viewed the F-12 not only as a superb technical achievement, but also as a potential source of flight data applicable to future commercial supersonic transports (SSTs). NASA therefore requested an instrumented SR-71 to conduct research, or to have their instrumentation packages installed on other USAF Lockheed research and development aircraft. Unable to accommodate either request, the Air Force offered NASA the two remaining YF-12s in storage at Edwards. With funds available from the cancelled X-15 and XB-70 programs, NASA accepted the offer and agreed to pay the operational expenses. Aerospace Defense Command (ADC) supplied maintenance and logistic support, and on 5 June 1969 a memorandum of understanding (MoU) was signed between the two parties.

Utilization of these high-speed research platforms was frequent, since NASA engineers at Langley were interested in using them for aerodynamic experiments and testing advanced structures. Lewis Research Establishment wanted to study propulsion, while Ames concentrated on inlet aerodynamics and correlating wind-tunnel data with actual flight data; additionally the aircraft could be used to support various specialized experimentation packages. Taken together, it was hoped that many problems 'worked around' during earlier test programs could be designed out of any future commercial venture, thus avoiding expensive mistakes.



▶ An early NASA flight test experiment conducted on YF-12A 60-6935 had a rear-facing camera installed on the lower fuselage adjacent to the nose landing gear to measure structural deflection of the fuselage during flight. The cross in a circle markings aided accurate camera focusing for chase aircraft and ground-based cameras. (NASA via Tony Landis)

Three months' work was needed to ready the two YF-12s (60-6935 and 60-6936) for flight. During this time instrumentation readily available to study aerodynamic loads and structural effects was installed by FRC technicians aboard 60-6935. Strain gauges were

◀ The loss of YF-12A 60-6936 on 11 December 1969 generated the need for a replacement. The Air Force supplied SR-71A 61-7951 on 16 July 1971. (NASA)

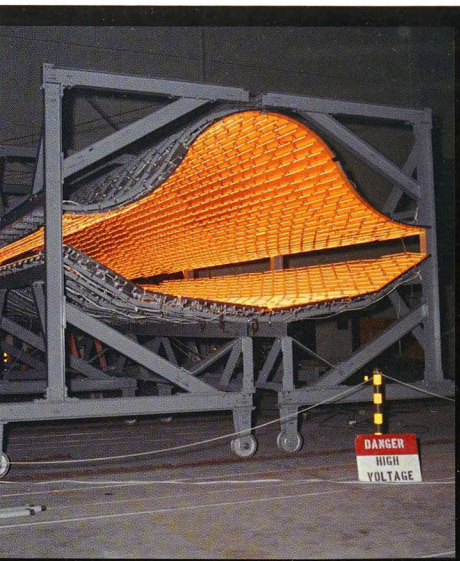
installed within the wing and fuselage and thermocouples mounted on the left side of the aircraft to measure high-Mach temperature readings.

On 11 December 1969, the joint NASA US Air Force flight-test programme was launched when for the first time in three years a YF-12 climbed away from Edwards. Phase one of the programme was controlled by the Air Force and consisted of developing procedures for establishing limitations for command and control and for working out possible bomber penetration tactics against an interceptor with the YF-12s capabilities. However, this phase of the programme was terminated during the closing stages of the 63rd flight of 60-6936 when it was lost on 24 June 1971. A fuel line fatigue fracture triggered a fire that engulfed the entire aircraft while it was on base leg into Edwards. Fortunately both Lt Col Ronald J. Layton and systems operator Maj William A, Curtis ejected safely before 6936 crashed into the middle of the dry lakebed and was totally destroyed.

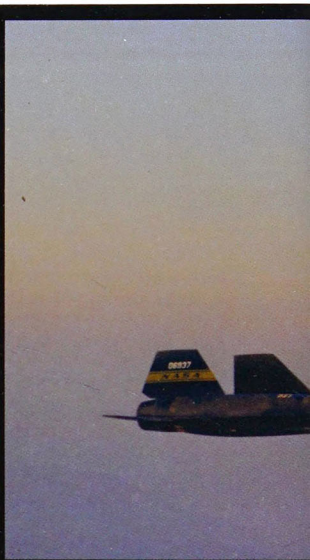
In contrast, the NASA programme was a long running success. YF-12 60-6935 became a real workhorse for NASA. A 'flight loads' research programme involved installing a camera within the fuselage to photograph the structure during moderate G manoeuvres. It revealed that under certain conditions the aft end of the fuselage deflected some 15cm from the centreline.

After the 22nd flight of 6935 on 16 June 1970, the airplane was grounded for nine months for instrumentation changes. Once these were completed, a check flight was completed on 22 March 1971, after which the folding ventral fin was removed for four flights to assess directional stability up to Mach 2.8.

▼ One condition governing the loan of 951 to NASA was that in addition to its being re-serialled 60-6937, it would also be referred to bizarrely as a YF-12C. (NASA via Tony Landis)



◀ YF-12A 60-6935 was grounded for over a year, between February 1972 until July 1973, during which time NASA conducted a series of structural heating tests utilizing thousands of quartz lamps. (NASA via Tony Landis)



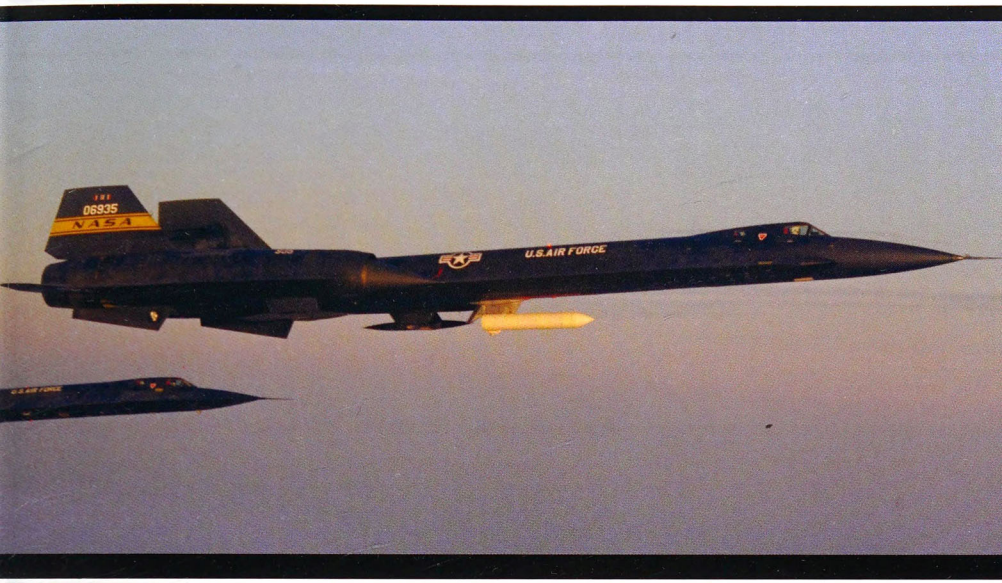
▶ During eight flight test sorties between October 1976 and October 1977, the remaining NASA YF-12A and 'YF-12C' flew together, with NASA 937 providing Mach 3 chase. Note the ceramic covering applied to the heat-transfer cylinder that was removed at cruise speed ballistically and the streamline camera housings under each engine nacelle to monitor the experiment. (NASA via Tony Landis)

NASA needed more aircraft, and the Air Force supplied an SR-71A (article 2002 serial 61-7951) on 16 July 1971. For some unexplained reason, the Air Force stipulated that the aircraft had to be referred to by NASA as an YF-12C, and it completed its first flight with NASA on 24 May 1972.

Studies carried out on various aspects of the aircraft's handling qualities revealed that inlet spike movement and bypass door operations were almost as effective as elevons and rudders in influencing the aircraft's flight path at high speed. Propulsion system and flight-control integration was an aspect of control testing tackled by the NASA programme in an effort to improve future mixed-compression inlet design. Airflow disturbance often culminated in an unstart, and the accompanying aerodynamic hiccups could hardly be tolerated in a supersonic passenger aircraft. This work led Lewis Research Center to develop a throat-bypass stability system, which was successfully tested on the YF-12. It used relief-type poppet valves in the inlet that could react to internal airflow transients much faster than the bypass doors. This valve-stabilized airflow mechanism complemented the inlet control system by providing sufficient time for the inlet shockwave geometry to reconfigure itself to maintain a 'started' inlet.

Another installation tested by NASA technicians and prepared by a Honeywell engineer proved so successful that it was later fitted to operational SR-71s – the Central Airborne Performance Analyzer (CAPA). This integrated automatic support system isolated faults and recorded the performance of 170 subsystems onto magnetic tape. Pre-and-post flight analysis of this onboard monitoring and diagnostic system proved highly cost effective and reduced maintenance man-hours significantly.

Between 1974 and 1976 a research programme was undertaken by NASA's Langley Research Center to investigate and evaluate titanium and composite materials. The Skunk Works was the prime contractor for three wing panel samples evaluated. These lightweight structures consisted of a weldbrazed titanium skin-stringer panel, a Rohr bond titanium



honeycomb-core panel and a boron aluminium-titanium core panel. All three components exceeded strength requirements.

One of the more unusual heat-transfer experiments supported by NASA was 'Coldwall'. For these test flights a hollow stainless steel cylinder was mounted under the fuselage of YF-12 6935 equipped with thermocouples and pressure-sensing equipment. It was then encased in a ceramic shell closed off at each end. Before flight, the cylinder was filled with liquid nitrogen to supercool it down to about minus 60°F. At Mach 3.0 the ceramic shell was ballistically removed, resulting in a classic heat-transfer experiment as the cylinder went from very cold to very hot almost instantaneously. Using the same cylinder, this experiment was then repeated in a wind tunnel, thereby validating ground research methods for future heat transfer experiments.

Aircraft 60-6937 was retired from the programme after its 88th flight with NASA on September 28 1978. YF-12 number 60-6935 continued operating until the flight programme ceased after its 145th NASA flight on 31 October 1979. A week later, Col J. Sullivan and Col R. Uppstrom ferried the aircraft to the Air Force museum at Wright-Patterson AFB, Ohio, where as the sole example of the YF-12 it is on permanent display.

In early 1990, NASA once again became involved in operating the SR-71 when it was decided to conduct a number of aeronautical experiments requiring the use of a supersonic test platform. Three SR-71s were placed on loan by the Department of Defense, and in order to comply with Federal Aviation Administration (FAA) regulations, serial numbers were changed. SR-71B '956 became NASA 831, and SR-71As '971 and '980 became NASA 832 and 844 respectively. Like the earlier programme, this too was conducted from Edwards AFB, and first of the three aircraft to be readied for flight was NASA 831. The first of three training flights were conducted on 1 July 1991, after which Lt Col Rod Dyckman certified Steve Ishmael as a NASA instructor pilot (IP). Thereafter Ishmael checked out a second NASA pilot, Rogers Smith, who in turn flew Marta Meyer and her husband Robert on an orientation flight, as they became the two flight test engineers on the programme.

▲ SR-71B 61-7956 (NASA 831) is readied for an early morning training flight from Edwards. Note the JP-7 under the aircraft that has leaked from the 'wet' fuel cells. (Paul F. Crickmore)

▶ The final SR-71 NASA flight-test team from top to bottom was Rogers Smith, Ed Schneider, Bob Meyer and Marta Bohn-Meyer. (NASA)

▶ NASA 831 slides clear of the tanker during a crew training flight, flown on this occasion by Rogers Smith and accompanied by Marta Bohn-Meyer – Marta was the first and only woman to be part of the SR-71 flying programme. On the US unlimited aerobatic team for two years, Marta was killed on 18 September 2005 while practising aerobatics. (NASA)

The most ambitious project to be conducted during this period was the Linear Aerospike SR-71 Experiment (LASRE). Its objective was to provide in-flight data that would enable Lockheed Martin to validate the computational predictive tools it had been using to determine the aerodynamic performance of a future potential reusable launch vehicle. The first of seven flights got under way on 31 October 1997, and during this flight lasting 1 hour 50 minutes aircraft 61-17980 (NASA 844) reached a maximum speed of Mach 1.2 and 33,000ft before recovering back at Edwards AFB. A second flight successfully verified the SR-71/pod configuration, and five further flights were conducted focusing on the experiment. On 4 March 1998, the first of two flights were completed, during which time gaseous helium and liquid nitrogen were cycled through the Boeing-Rocketdyne J2-S linear aerospike engine. Three more flights were successfully completed in the spring and summer of 1998, during which liquid oxygen was cycled through the engine. However, numerous cryogenic leaks were discovered, and despite the engine being 'hot fired' on the ground on two occasions for a total of three seconds, it was deemed to be too dangerous to fire up the engine with its liquid hydrogen fuel while aloft. An investigation into the leaks determined that these would be too difficult and expensive to rectify, and in the event, sufficient information had already been gathered to predict the hot gas effects of an aerospike engine firing during flight: therefore the programme was terminated in November 1998.

The last flight of any SR-71 took place during the Edwards AFB open house weekend of 9/10 October 1999. On Saturday NASA crew Rogers Smith and Robert Meyer flew 61-7980 (NASA 844) up to a speed of Mach 3.21 and an altitude of 80,100ft. Unfortunately, it would prove to be its final flight, as the flight scheduled for Sunday 10 October had to be cancelled due to a maintenance problem.

CHAPTER 15

SHUTDOWN

Two operating issues plagued the Senior Crown programme for most of its life, namely its high operating costs in comparison to other fixed-wing assets and provision to fund those costs. Initially the cost-versus-benefit argument was straightforward to justify (particularly during the Vietnam War) on the basis that the detailed, broad synoptic coverage secured simultaneously by the platform was essential for both national and theatre commanders and that the acquisition of such material was beyond the capability of other platforms to secure – especially in high-threat environments.

Senior Crown's programme element number at the Pentagon was PE 11133F (the first digit 1 denoted the major force programme as strategic). Initially DoD funding for this was provisioned for under a special 'black world' category. This protected funds for highly-classified programmes from scrutiny and also stabilized funding levels from cyclical budgetary raids that were the bane of 'white world' programmes. Transfer of the management of Senior Crown from the Air Staff Programs division to the Air Staff Operations division (XOORS) occurred shortly before August 1969. Then, in 1975, XOORS was redesignated XOORZ and SR-71 funding was moved from the black into the 'white world'.

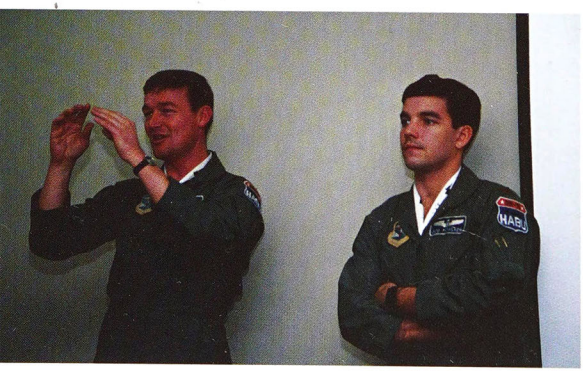
When Lockheed Martin approached the Air Force for clearance to use an SR-71 in a film they were planning to make about the aircraft near the end of its career, the SAC mafia denied permission. AFLC, however, came to the rescue and made 955 available – note the painted-out serial and Skunk logo. (Lockheed Martin via Tony Landis)

▲ On 21 January 1990 Majs Steve Grzebiniak and his RSO Jim Greenwood ferried 962 back to Beale from Kadena AB. This creative piece of tail art said it all. Today this aircraft can be seen at the Imperial War Museum, Duxford, Cambridgeshire, England and is the only SR-71 that's on display outside the USA. (USAF via Don Emmons)

From then on Senior Crown had to compete for its funding against all other DoD programmes. This situation generated two headaches for the SR-71's Program Element Monitor (PEM) at XOORZ. Firstly, the classified nature of the programme meant that it was designated Top Secret/Sensitive Compartmented Information (TS/SCI), which in practical terms meant that only those with specific clearances and a need-to-know were party to the intelligence it generated, which inevitably corseted the level of support the PEM could muster. The second issue was that the first digit in the programme element number, identifying Senior Crown as 'strategic', meant that it fell under the command of SAC, whose primary responsibility was to secure funding for two of the three very expensive legs of the nuclear triad – nuclear intercontinental ballistic missiles and its force of nuclear equipped B-52 bombers (a budgetary situation further exasperated by the need to upgrade both systems and introduce the B-1 bomber). Therefore to some extent, SAC's later anti-SR-71stance is understandable, since they were saddled with its operating costs (which were not inconsiderable), while other government agencies, including the US Navy and US Army, who were major beneficiaries of its reconnaissance, contributed nothing to its upkeep.

One of the vagaries of change in any large organization, especially at the top, is that the incumbent has his/her own agenda. When ex-SR-71 pilot (later to become 9th SRW commander and ultimately commander of Tactical Air Command), Gen Jerry O'Malley, was tragically killed in a freak accident on 20 April 1985, the USAF lost not only a top leader tipped to become the Air Force's next Chief of Staff, but also one of Senior Crown's most powerful supporters. The SR-71 didn't feature in the non-O'Malley Air Force. The platform was 'living on borrowed time' without an electro-optical system for its cameras and without its Advanced Synthetic Aperture Radar System (ASARS) connected to a data link to enable real-time/near real-time transmission of its reconnaissance data. Unequivocally the programme's main detractor was Chief of Staff, General Larry Welch, but other prominent/influential figures included General Dugan (AF/XO), General John Chain (CINCSAC), General Ron Fogleman (AF/Program Requirements), General Doyle (Chief of SAC Intelligence (SAC/IN)), Col Tanner (also of SAC/IN) and General Leo Smith of the Budget Review Board. Their assault on Senior Crown began from mid-1986, and the main reason that they cited for retiring the SR-71 was cost and marginal benefits over satellites. By 1988 it looked as though their efforts would be successful. However, Admiral Lee Baggot (CINCLANT) insisted that no other platforms (including satellites) were capable of gathering the vital intelligence he required regarding the movement of Soviet subs based on the Kola peninsula, and he took his battle right to the JCS and managed to secure funding for Det 4 for a further year. In addition, Lt Col Curt Osterheld (now a very resourceful SR-71 PEM at XOORZ) was able to secure the commitment from a staffer on the Senate Appropriations Committee for

▼ A press conference was held within the Det 4 operations building following the earlier departure of 964. Here Majs Don Watkins (left) and his RSO Bob Fowlkes are seen answering questions – they ferried the last SR-71 to leave the UK ('967) back to Beale the next day. (Paul F. Crickmore)



▲ With the cooperation of Beale's base commander, Lockheed photographer Eric Schulzinger composed and took this historic masterpiece in February 1990. The SR-71 at the back is the hybrid SR-71C pilot trainer. (Lockheed Martin)

$46 million that enabled Det 1 and the SR-71's logistics facility at Palmdale to remain open for fiscal year (FY) 1989. But as the end of that fiscal year approached, the future of the programme looked increasingly bleak, and on 1 October 1989 all SR-71 operations were suspended with the exception of a minimum number of proficiency flights. Finally, on 22 November, despite the misgivings of 40 members of Congress, including chairman of the Senate Committee on Armed Services Senator Sam Nunn, Senior Crown was terminated. Two months later, on 26 January 1990, the SR-71 was officially decommissioned in a ceremony at Beale AFB – the programme's detractors had finally won the day. What was to be the Air Force's final flight of an SR-71 took place on 6 March 1990 when Ed Yeilding and J. T. Vida flew '972 on a west to east coast record-breaking flight of the United States before landing at the Smithsonian National Aerospace Museum, Washington DC, where it was handed over for permanent display.

In compliance with the decommission decision, three SR-71s were placed in storage at Air Force Site 2 Palmdale. Two other 'A models', together with the sole surviving two-seat trainer, '956, were loaned to NASA as supersonic test platforms to be flown from Edwards AFB. Virtually all the remaining aircraft, including the surviving A-12 Oxcarts, were cut up, moved and reconstructed as exhibits at various museums throughout the United States.

On 2 August 1990, Iraq invaded Kuwait and within days of the invasion Ben Rich (now president of the Skunk Works) phoned General Michael Loh, Air Force Vice Chief of Staff, and informed him that he could have three SR-71s ready for operations over the Gulf within 90 days. General Loh committed to floating the idea and getting back. But about a week later, Rich received a call saying that SecDef, Dick Cheney, vetoed the idea, commenting along the lines, 'I retired that aeroplane once, I'm not going to do it again. If I bring it back now, I'll never get rid of it'.

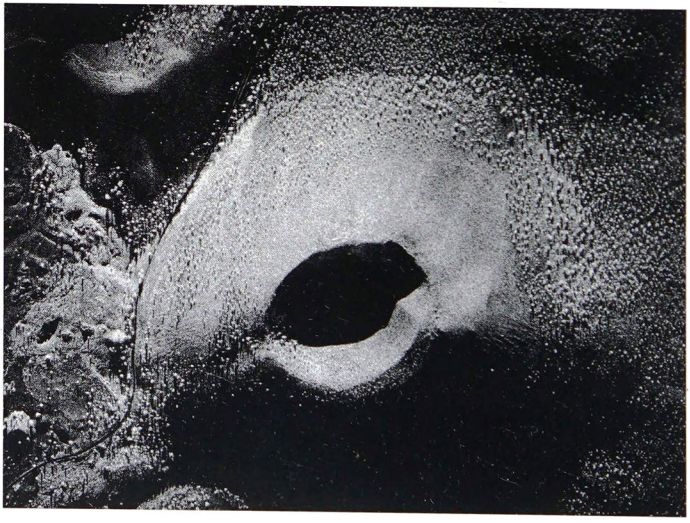
▼ Two SR-71 nose sections are seen stacked and awaiting transportation back to Beale from RAF Mildenhall following the termination of Senior Crown. (Paul F. Crickmore)

▲ The radome housing the C3 Com data-link antenna, fitted along with the ASARS equipment, was located below bay C, just forward of the nose undercarriage well. A digital cassette recorder system provided for the recording of both ASARS and ELINT data. Data could be transmitted in real time if the aircraft was within range of a receiving station; if not, it could be downloaded quickly once the aircraft was in range. Senior Crown detractors starved the programme of funding, which ensured that this essential capability was never made available until it was too late. (USAF)

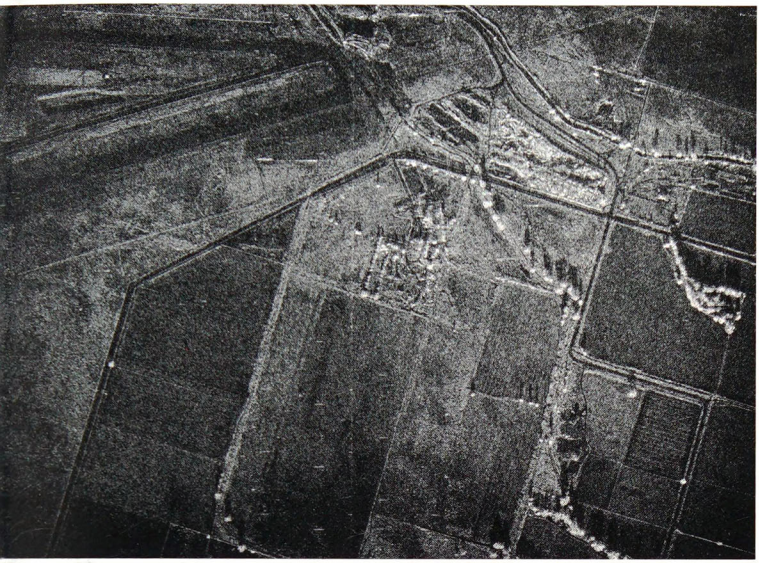
That *Desert Storm*, the subsequent Allied operation that ousted Saddam Hussein's forces from Kuwait, was a spectacular success is beyond dispute. However, one of the lessons learned from the 41-day campaign was that there was a lack of timely reconnaissance material available to General Schwarzkopf's field commanders, a gap that could have been bridged by the SR-71.

Further discontent about the decision to terminate Senior Crown re-emerged during the spring of 1994, when relations between North Korea and the United States sunk to another low over the North's refusal to allow inspection of their nuclear sites. This action prompted Senator Robert Byrd and several members of Congress to contend that back in 1990 the Pentagon had consistently lied about the supposed readiness of an SR-71 replacement. Their campaigning paid dividends, as noted in the Department of Defense Appropriation Bill 1995 dated 20 July, when $100,000,000 was made available for the reactivation of a modest (three-plane) SR-71 Blackbird reconnaissance aircraft contingent for intelligence operations as recommended by the Senate Armed Services Committee. Furthermore, in an unprecedented move, their report went on to detail how and where the money was to be spent during that first year, including co-locating the new detachment at Edwards AFB in order to share some operating facilities with NASA, thereby helping to reduce costs, as well as implementing a robust sensor update programme.

Recognizing the utility of the aircraft's systems to both national and tactical intelligence commanders, the Committee also directed that costs should be evenly shared by the intelligence community and the Tactical Intelligence and Related Activities (TIARA) budget.



▶ This selection of hi-res ASARS I images were taken during SR-71 test sorties. In this digitized format such images could be transmitted via the datalink to ground commanders in real time/ near real time. This is Sunset Crater. (Goodyear)



◀ This 3ft x 3ft Spotlight ASARS I image captures an area 6,100ft x 6,100ft. (Goodyear)

▼ Part of Nellis AFB imaged by ASARS I on a 3ft x 3ft Spotlight setting. (Goodyear)

The conferees went on to reaffirm their support for the goals and objectives of the department's endurance unmanned aerial vehicle programme, and further directed that the SR-71 programme be wholly designated as a TIARA program and that the Air Force assume total responsibility for sustaining out-year budget requirements.

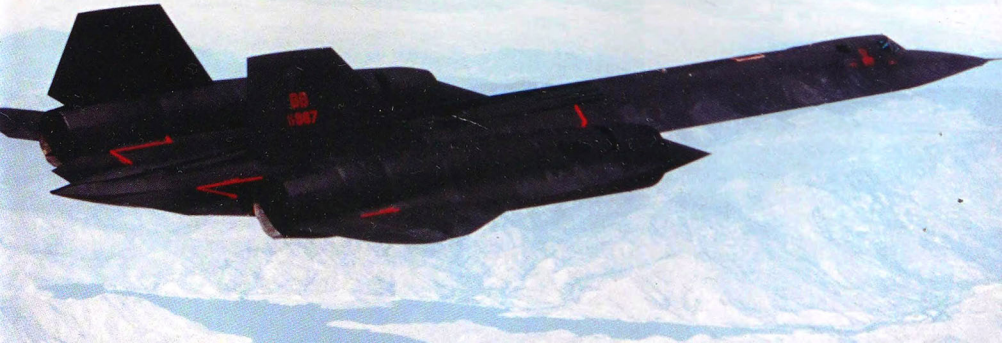
The scale and detail of this Congressionally Directed Action or CDA is astonishing, and no doubt acted as a red rag to a bull to those senior Air Force officers that had worked so tirelessly to terminate Senior Crown. In a memo to the Deputy Chief of Staff, Plans and Operations USAF, from the Director, DARO, Major General Kenneth R. Israel, dated 24 October 1994, the latter pointedly recognized that 'currently, no funding has been identified for FY1996 and out'.

Of the three platforms placed in deep storage at Palmdale, only 61-7967 was called to arms by the Air Force. Aircraft reactivation began on 5 January 1995, when '967 undertook a fuel leak evaluation. Seven days later, at 11:26hrs, NASA crew Steve Ishmael and Research Systems Operator Marta Bohn-Meyer got airborne from Edwards in '971 on a 26-minute ferry flight that terminated at Lockheed Martin's Skunk Works, Plant 10, Building 602, Palmdale. Over the next three months, ASARS, together with other sensors previously in storage at Luke AFB, Arizona, were installed. At 10:18hrs on 26 April, NASA crew

▶ This selected enlargement demonstrates the step change in image resolution attained by ASARS I. (Goodyear)

Ed Schneider and Marta completed a 34-minute FCF on '971. A month later Ed and Marta's husband Bob Meyer conducted '971's second and final FCF, which lasted 2½ hours. However, it took seven further check flights to wring out all the glitches in '967, the final one being successfully completed on 12 January 1996.

Three Air Force crews were selected to fly the aircraft. To save money, the plan was that two crews would always be 'mission ready' qualified, while the third crew would be 'mission capable'. While crew proficiency training got under way in the simulator and the 'B' model, R&D funds were used to develop and install the long awaited datalink, which was manufactured by C3 Com. of Salt Lake City; its antenna was housed in a small radome just forward of the front undercarriage wheel well referred to as 'the wart'. A digital cassette



▼ The limited-capability SR-71 reactivation plan began on 5 January 1995, when 967 undertook a fuel leak evaluation. The aircraft finally completed a successful FCF on 12 January 1996. (Jim Ross/NASA)

recorder system (DCRsi) provided recording and playback of both ELINT and ASARS data, enabling the SR-71 to provide near-real-time data provided it was within 300nml line-of-sight range of a receiving station; if not, the entire recorded collection could be downloaded in 10 minutes once within station range. Also under development was an electro-optical version of the TEOC, the aim of which was to also provide a digitized image that would also be downloaded in a way similar to the ASARS I imagery. This initiative was undertaken by Recon Optical, and the project lead was Nance Romans.

▲ On 1 February 1996, '971 participated in Red Flag, and on 14 June 1996, while being flown by Ed Schnieder and Blair Bozek, the ASARS I data transfer link was successfully demonstrated. (Jim Ross/NASA)

But the CDA had created an immense amount of resentment amongst several members of Congress and key AF officers, including none other than the now USAF Chief of Staff, General Fogleman. Det 2 was operationally ready to deploy, but they were never tasked to do so by the Air Force. Basically, senior AF figures were planning for a 12-month womb to tomb scenario, believing that Congress would be unable to push through additional funding for a second year. However, against the odds, $35 million of further funds were appropriated for the SR-71, as noted in the National Defence Authorization Act for FY 1996: 'The committee is pleased with the timely and cost-effective reconstitution of a contingency force manned, high speed, penetrating reconnaissance aircraft as a hedge until penetrating unmanned aerial vehicles are more widely fielded.'

Despite monies being appropriated, significantly, there was no mention of it in the Senate Authorization Bill. Furthermore, when a staffer on the House Select Committee on Intelligence pointed out that section 504 of the 1947 National Security Act, actually prohibits the obligation of funds for intelligence activities not specifically authorized, this was taken up in a meeting of Congress in December 1995. The Air Staff were left to debate where this technicality left the SR-71, given that the budget was split between two pots of money – Aircraft Procurement and Operation & Maintenance. With conflicting guidance coming from Congress on how section 504 should be interpreted, lawyers became involved, after which it was determined that in order to comply with the letter of the law, SR-71 operations had to be suspended. A signal was therefore dispatched to that effect at 23:00 (Z) on 16 April 1996, and all Air Force SR-71 flying ceased yet again.

◀ On 16 July 1997, Majs Tom McCleary and his RSO Jim Greenwood departed Beale in SR-71A '971. The mission flown within the United States was to evaluate a film then being developed. This image was taken by one of the aircraft's TEOCs, loaded with standard 3412 black and white film. (McDonald Douglas via Chuck Hamilton)

While grounded, two classified requests were made for SR-71 operations, but both were denied based upon the interpretation of intelligence laws. But with members

▶ This image taken by 971's other TEOC shows an identical area of Lewiston, Idaho, but filmed on 2443 infrared film. This has the ability to discern live or dead vegetation (live is coloured red), thus revealing camouflaged areas. (McDonald Douglas via Chuck Hamilton)

of the Senate Appropriations Committee enraged at the way they'd been circumvented over the decision to suspend SR-71 operations, they made it known that if their bid to secure $30 million worth of funding for the SR-71 was obstructed, they threatened to have section 8080 of the Appropriations Act eliminated. After this, their next tactic would have been to get the Intelligence Authorization Act for FY97 defeated on the House and Senate floors, which in turn would have led to the suspension of *all* intelligence activities! Perhaps not surprisingly, the bill was passed and flying resumed once more.

However, by now the 'powers that be' in the Air Force had had enough of 'unwanted intervention' by Congress in 'their affairs' and when the White House insisted that the Pentagon find savings in the defence budget, senior AF officers seized their opportunity and offered up the SR-71. On 14 October 1997 President Bill Clinton line-item vetoed the programme, and with immediate effect, all Air Force Blackbird flying ceased, this time permanently.

In yet another twist later that year, the US Supreme Court ruled that the line-item veto was unconstitutional. Two other programmes that fell victim of this veto process were reinstated by the Air Force – not, however, the SR-71. Yet again, elements within Congress stood their ground, stating that funds totalling $39 million were available for the programme and demanding to know the source of the hold-up. However, when required, the bureaucratic process can be made to slow to the pace of a snail on Valium, and by stalling, on 1 October 1998 (the start of FY 1999), whatever funding that had remained was exhausted. The SR-71 wasn't in the budget and it was all over for good.

Throughout all the political shenanigans during the reactivation of Det 2, the SR-71 had flown a total of 150 training sorties during 365.7 flight hours. The final Det 2 SR-71 sortie was flown on 10 October 1997 in aircraft '967 on training route Brandy, which lasted 4.1 hours.

▲ During the early 1980s the Air Force began a major modification programme on its tanker fleet, replacing the old Pratt & Whitney J57 turbojets with four new CFM56 turbofans (designated F108-CF-100 by the military). The resulting KC-135R was more powerful, quieter and far more fuel-efficient. Tests completed with the SR-71 indicated that the new tanker was able to increase its maximum speed by an additional 20 KIAS, allowing the SR-71 to refuel at 375 KIAS – a considerable improvement, especially during heavy-weight operations. (Blair Bozak)

CHAPTER 16

PATCHES

ALL PATCHES FEATURED HERE ARE BY COURTESY OF THE RONALD GIROUARD COLLECTION.

▶ 9th SRW patches were worn on the flight suit or flight jacket. The first is a low-visibility example. Next is the patch that was worn during the 1970s and 80s. The Semper Paratus patch (meaning Always Prepared – it's also the motto of the US Coast Guard) is the original wing patch dating from the 1960s.

◀ 1st SRS patch.

▲ This is the only patch that was worn on a pilot's or RSO's pressure suit.

▼ Pilots and RSOs were qualified to wear this patch once they'd completed their first Mach 3 flight.

◀ Pilots and RSOs had to successfully complete their first operational mission before they could wear this patch.

◀ The 99th SRS was deactivated as an SR-71 squadron on 1 April 1971.

▶ The SR-71 detachment at Kadena was originally known as OL-8 (Operating Location 8); it was redesignated OLRK on 30 October 1970. It then became OLKA on 26 October 1971 before finally being designated Detachment 1 in August 1974.

▲ An early Det 1 patch.

▶ A very rare subdued Det 1 patch.

▲ Detachment 2 was formed at Edwards between 1995 and 1997 while a limited SR-71 programme was briefly formed.

▲ Detachment 4 of the 9th SRW operated from RAF Mildenhall, Suffolk, England.

◀ Patch worn by SR-71 Air Force Logistics Command, Detachment 6 flight crews based at Palmdale.

◀ This is an adaptation of the SR-71 Mach 3 patch that was worn by SR-71 pilots while using the T-38 Talon crew proficiency trainer.

▶ A selection of extremely rare flight test patches worn by crews participating in early combined test operations with the SR-71 and YF-12 at Edwards AFB, including that of the 4786th Test Squadron.

◀ Rear patches worn by Air Force and NASA flight crews participating in F-12/YF-12 flight tests from Edwards AFB.

▲ Patches worn by CIA Oxcart pilots – Cygnus, the name given to the aircraft by its Agency pilots, and the 1129th Special Activities Squadron, The Roadrunners.

▲ A-12 Mach 3 patch.

APPENDICES

APPENDIX 1 BLACK SHIELD MISSIONS

Date	Mission	Target	Pilot	Article	Duration/hours	Alt/ft
31/05/67	BSX001	North Vietnam	Vojvodich	131	3:55	80K
10/06/67	BSX003	North Vietnam	Weeks	131	4:58	82K
20/06/67	BX6705	North Vietnam	Layton	127	4:58	82K
30/06/67	BX6706	North Vietnam	Weeks	129	4:58	82K
13/07/67	BX6708	North Vietnam	Collins	127	3:40	82.1K
19/07/67	BX6709	North Vietnam	Sullivan	131	4:58	82K
20/07/67	BX6710	North Vietnam	Collins	129	4:55	82.45K
21/08/67	BX6716	North Vietnam	Vojvodich	131	4:58	82K
31/08/67	BX6718	North Vietnam	Layton	127	5:12	81K
16/09/67	BX6722	North Vietnam	Weeks	129	4:01	80K
17/09/67	BX6723	North Vietnam	Collins	131	4:00	81K
04/10/67	BX6725	North Vietnam	Collins	127	4:09	81K
06/10/67	BX6727	North Vietnam	Murray	131	2:20	81K
15/10/67	BX6728	North Vietnam	Collins	131	3:41	81K
18/10/67	BX6729	North Vietnam	Murray	129	4:01	81K
28/10/67	BX6732	North Vietnam	Sullivan	131	3:49	83.5K
29/10/67	BX6733	North Vietnam	Murray	127	3:56	82K
30/10/67	BX6734	North Vietnam	Sullivan	129	3:44	85K
08/12/67	BX6737	Cambodia/Laos	Vojvodich	131	3:59	82.5K
10/12/67	BX6738	Cambodia/Laos	Layton	131	3:51	81K
15/12/67	BX6739	North Vietnam	Vojvodich	127	4:09	86K
16/12/67	BX6740	North Vietnam	Layton	131	3:56	86.2K
04/01/68	BX6842	North Vietnam	Layton	127	3:57	85.1K
05/01/68	BX6843	North Vietnam	Weeks	131	4:09	86K
26/01/68	BX6847	North Korea	Weeks	131	4:00	83.5K
16/02/68	BX6851	North Vietnam	Collins	127	3:54	85.6K
19/02/68	BX6853	North Korea	Murray	127	3:39	83.5K
08/03/68	BX6856	North Vietnam	Vojvodich	127	4:01	85.5K
06/05/68	BX6858	North Korea	Layton	127	3:30	84.7K

APPENDIX 2 DET 1 MISSIONS

COMPLETE DET 1 MISSION RECORD

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
09/03/68	978	10:00	BROWN Buddy	JENSEN Dave	Ferry to OL-8	6.6
11/03/68	976	10:00	O'MALLEY Jerome/ Jerry	PAYNE Edward/Ed.	Ferry to OL-8	6.5
13/03/68	974	10:00	SPENCER Boh	BRANHAM Keith	Ferry to OL-8	6.3
18/03/68	978	10:00	BROWN Buddy	JENSEN Dave	CCTM	1.5
21/03/68	976	12:00	O'MALLEY Jerry	PAYNE Ed.	HABU	5.1
24/03/68	976	11:00	O'MALLEY Jerry	PAYNE Ed.	RTB FERRY	1.5
26/03/68	974	11:51	WATKINS Jim	DEMPSTER Dave	CCTM	1.7
28/03/68	976	11:00	SPENCER Bob	BRANHAM Keith	CCTM	1.7
01/04/68	978	12:00	BROWN Buddy	JENSEN Dave	CCTM	1.7
04/04/68	976	12:00	O'MALLEY Jerry	PAYNE Ed.	FCF/E	1.7
05/04/68	974	14:00	WATKINS Jim	DEMPSTER Dave	CCTM	1.7
08/04/68	978	12:00	SPENCER Bob	BRANHAM Keith	CCTM	1.6
10/04/68	978		BROWN Buddy	JENSEN Dave	CCTM	
10/04/68	976	14:00	O'MALLEY Jerry	PAYNE Ed.	HABU	3.9
12/04/68	974	12:00	BROWN Buddy	JENSEN Dave	CCTM	1.7
15/04/68	976	13:22	WATKINS Jim	DEMPSTER Dave	CCTM	2.4
16/04/68	976	16:00	SPENCER Bah	BRANHAM Keith	FCF/E	1.1
18/04/68	978	11:00	BROWN Buddy	JENSEN Dave	HABU	2.4
19/04/68	974	12:00	WATKINS Jim	DEMPSTER Dave	HABU	5.4
20/01/68	978	13:00	BROWN Buddy	JENSEN Dave	RTB FERRY	2.3
22/04/68	976	11:00	SPENCER Bob	BRANHAM Keith	HABU	5.6
24/04/68	978	10:00	O'MALLEY Jeny	PAYNE Ed.	FCF/E	1.9
27/04/68	976	12:20	BROWN Buddy	JENSEN Dave	HABU	3
28/04/68	974	14:00	WATKINS Jim	DEMPSTER Dave	HABU	3.8
28/04/68	978	15:00	O'MALLEY Jerry	PAYNE Ed.	FCF/ELECT	1.6
29/04/68	976	10:58	BROWN Buddy	JENSEN Dave	RTB FERRY TO OL-8	2.3
02/05/68	976	12:00	SPENCER Bob	BRANHAM Keith	CCTM	2.6
04/05/68	974		WATKINS Jim	DEMPSTER Dave	FCF/E	1.6
05/05/68	978		SPENCER Bob	BRANHAM Keith	HABU	5.4
08/05/68	976		WATKINS Jim	DEMPSTER Dave	HABU	5.7
09/05/68	978		DEVALL Larry	SHOEMAKER Clyde	FCF/E	2.3
11/05/68	976		STORRIE John	MALLOZZIE Cos	FCF/E	1.7
11/05/68	974		SPENCER Bob	BRANHAM Keith	HABU	4.5
13/05/68	974		WATKINS Jim	DEMPSTER Dave	HABU	5.6
16/05/68	976		STORRIE John	MALLOZZIE Cos	HABU	5.2
17/05/68	978		DEVALL Larry	SHOEMAKER Clyde	HABU	4.3
19/05/68	976		WALBRECHT Don	LOIGNON Phil	FCF/E	1.7
19/05/68	978		WATKINS Jim	DEMPSTER Dave	FCF/E	1.9
22/05/68	974		STORRIE John	MALLOZZIE Cos	HABU	3.1
24/05/68	976		DEVALL Larry	SHOEMAKER Clyde	HABU	5.5
25/05/68	978		WALBRECHT Don	LOIGNON Phil	HABU	5.3
27/05/68	978		WALBRECHT Don	LOIGNON Phil	FCF/E	1.8
29/05/68	974		WATKINS Jim	DEMPSTER Dave	CCTM	2.5
03/06/68	976		STORRIE John	MALLOZZIE Cos	HABU	1.3
03/06/68	978		DEVALL Larry	SHOEMAKER Clyde	HABU	4.3
05/06/68	974		BEVACQUA Tony	CREWS Mac	CCTM	2.3
07/06/68	978		WALBRECHT Don	LOIGNON Phil	CCTM	2.3
11/06/68	976		STORRIE John	MALLOZZIE Cos	CCTM	2.7
14/06/68	974		DEVALL Larry	SHOEMAKER Clyde	CCTM	1.7
15/06/68	978		BEVACQUA Tony	MALLOZZIE Cos	CCTM	1.8
17/06/68	976		WALBRECHT Don	LOIGNON Phil	CCTM	
18/06/68	974		WALBRECHT Don	LOIGNON Phil	HABU	4.1
19/06/68	976		STORRIE John	MALLOZZIE Cos	CCTM	1.9
23/06/68	978		BEVACQUA Tony	CREWS Mac	HABU	5.4
25/06/68	974		STORRIE John	MALLOZZIE Cos	HABU	4.3
26/06/68	976		DEVALL Larry	SHOEMAKER Clyde	CCTM	0.8
29/06/68	974		COLLINS Pete	SHOEMAKER Clyde	CCTM	2.3
30/06/68	978		WALBRECHT Don	LOIGNON Phil	HABU	5.2
03/07/68	974		COLLINS Pete	SEAGROVES Connie	CCTM	
04/07/68	976		BEVACQUA Tony	CREWS Mac	HABU	6
05/07/68	974		COLLINS Pete	SEAGROVES Connie	CCTM	1.6
07/07/68	978		STORRIE John	MALLOZZIE Cos	CCTM	2.7
08/07/68	976	11:00	WALBRECHT Don	LOIGNON Phil	CCTM	1.5
10/07/68	978	11:00	BEVACQUA Tony	CREWS Mac	CCTM	1.7
12/07/68	976	14:00	STORRIE John	MALLOZZIE Cos	HABU	3.9
14/07/68	978	10:00	COLLINS Pete	SEAGROVES Connie	CCTM	2.3
15/07/68	974	10:00	WALBRECHT Don	LOIGNON Phil	CCTM	1.6
17/07/68	976	10:15	STORRIE John	MALLOZZIE Cos	CCTM	2.6
18/07/68	976	14:00	COLLINS Pete	SEAGROVES Connie	HABU	5.3
19/07/68	974	12:00	BEVACQUA Tony	CREWS Mac	CCTM	1.8
20/07/68	978	15:00	HALLORAN Pat	JARVIS Mort	CCTM	2.1

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
23/07/68	978	13:45	WALBRECHT Don	LOIGNON Phil	HABU	5.1
24/07/68	976	14:00	COLLINS Pete	SEAGROVES Connie	FCF/PHASE	2.3
26/07/68	974	09:01	HALLORAN Pat	JARVIS Mort	HABU	2.1
26/07/68	976	10:08	BEVACQUA Tony	CREWS Mac	HABU	6
28/07/68	974	09:10	HALLORAN Pat	JARVIS Mort	HABU	5.3
01/08/68	978	10:15	WALBRECHT Don	LOIGNON Phil	CCTM	2.5
02/08/68	974	10:30	COLLINS Pete	SEAGROVES Connie	CCTM	1.6
04/08/68	974	10.00	ST MARTIN Roy	DREADEN Cecil	FCF	1.7
05/08/68	976	13:25	BEVACQUA Tony	CREWS Mac	CCTM	2.3
07/08/68	978	10:45	HALLORAN Pat	JARVIS Mort	CCTM	2.3
09/08/68	974	10:45	COLLINS Pete	SEAGROVES Connie	CCTM	2.3
11/08/68	978	10:05	ST MARTIN Roy	BREADEN Cecil	CCTM	0.5
12/08/68	974	08:50	BEVACQUA Tony	CREWS Mac	HABU	5.5
14/08/68	976	10:50	HALLORAN Pat	JARVIS Mort	CCTM	2.4
16/08/68	976	10.25	COLLINS Pete	SEAGROVES Cannie	FCF	2.1
17/08/68	974	14:58	HALLORAN Pat	JARVIS Mort	HABU	0.6
17/08/68	978	14:00	COLLINS Pete	SEAGROVES Connie	HABU	1.9
18/08/68	978	13:35	COLLINS Pete	SEAGROVES Connie	HABU	4
18/08/68	974	14:15	HALLORAN Pat	JARVIS Mort	HABU	4.1
19/08/68	976	11:05	BULL George	Mc NEER Red	CCTM	2.4
21/08/68	978	08:50	ST MARTIN Roy	BREADEN Cecil	HABU	5.4
23/08/68	978	11:55	COLLINS Pete	SEAGROVES Connie	CCTM	2.3
29/08/68	974	10:06	COLLINS Pete	SEAGROVES Connie	HABU	1.7
01/09/68	976	12:55	HALLORAN Pat	JARVIS Mort	CCTM	1.3
02/09/68	974	11:35	BULL George	Mc NEER Red	CCTM	1.3
06/09/68	978	12:00	ST MARTIN Roy	BREADEN Cecil	CCTM	1.1
06/09/68	974	13:00	HALLORAN Pat	JARVIS Mort	CCTM	1
08/09/68	974	09:05	BULL George	Mc NEER Red	HABU	4.3
09/09/68	978	12:05	COLLINS Pete	SEAGROVES Connie	CCTM	0.9
10/09/68	976	09:50	HALLORAN Pat	JARVIS Mort	CCTM	2.3
12/09/68	980	08:00	SHELTON Dale	DOGGESS Larry	FERRY TO OL-8	6.3
13/09/68	976	06:00	COLLINS Pete	SEAGROVES Connie	FERRY TO SC-5	
14/09/68	980	11:55	SHELLON Dale	BOGGESS Larry	CCTM K3	2.5
15/09/68	970	02:00	HICHEW Al	SCHMITTOU Tom	FERRY TO OL-8	6.3
16/09/68	974	06:00	HALLORAN Pat	JARVIS Mort	FERRY TO SC-5	
17/09/68	980	10:00	ST MARTIN Roy	BREADEN Cecil	HABU	3.9
17/09/68	970	11:16	BULL George	Mc NEER Red	CCTM K3	2.4
18/09/68	962	02:00	CAMPBELL Bill	PENNINGTON Al	FERRY TO OL-8	5.9
18/09/68	980	13:00	BULL George	Mc NEER Red	HABU	4
19/09/68	978	06:00	HICHEW Al	SCHMITTOU Tom	FERRY TO SC-5	
19/09/68	962	13:05	CAMPBELL Bill	PENNINGTON Al	CCTM K3	2.3
20/09/68	980	09:05	SHELTON Dale	BOGGESS Larry	CCTM K3	2.2
25/09/68	970	09:25	SHELTON Dale	BOGGESS Larry	HABU	5.7
26/09/68	980		ST MARTIN Roy	BREADEN Cecil	CCTM	
30/09/68	962	12:00	CAMPBELL Bill	PENNINGTON Al	HABU	5.8
01/10/68	970	10:55	ST MARTIN Roy	BREADEN Cecil	HABU	6.1
02/10/68	980	10:55	BULL George	Mc NEER Red	CCTM K3	0.4
03/10/68	962	11:20	BULL George	Mc NEER Red	HABU	5.7
04/10/68	970	09:15	SHELTON Dale	BOGGESS Larry	HABU	1
05/10/68	980	10:15	Mc CALLUM Brian	LOCKE Bobby	CCTM K3	0.6
07/10/68	980	10:40	CAMPBELL Bill	PENNINGTON Al	CCTM K3	2.4
10/10/68	970	09:30	BULL George	Mc NEER Red	CCTM K3	2.2
12/10/68	980	11:55	SHELTON Dale	BOGGESS Larry	CCTM K3	2.4
13/10/68	970	11:40	SHELTON Dale	BOGGESS Larry	HABU	4.1
16/10/68	980	10:55	CAMPBELL Bill	PENNINGTON Al	HABU	4.6
17/10/68	962	12:00	Mc CALLUM Brian	LOCKE Bobby	HABU	4.6
18/10/68	980	14:32	CAMPBELL Bill	PENNINGTON Al	RTB FERRY	2.3
20/10/68	970	12:00	BULL George	Mc NEER Red	HABU	5.7
23/10/68	980	11:31	SHELTON Dale	BOGGESS Larry	CCTM K3	1.1
25/10/68	980	09:30	CAMPBELL Bill	PENNINGTON Al	CCTM K3	2.3
26/10/68	962	10:30	DAUBS Larry	ROETCISOENDER Bob	CCTM K3	2.4
26/10/68	980	11:40	Mc CALLUM Brian	LOCKE Bobby	CCTM K3	2.4
27/10/68	970		SHELTON Dale	BOGGESS Larry	CCTM K3	
29/10/68	980	10:30	SHELTON Dale	BOGGESS Larry	CCTM K3	2.4
30/10/68	970	11:30	CAMPBALL Bill	PENNINGTON Al	CCTM K3	2.4
03/11/68	970	11:45	CAMPBALL Bill	PENNINGTON Al	HARU	5.7
04/11/68	962	10:00	CAMPBELL Bobby	KRAUS Jon	CCTM K3	2.6
04/11/68	980	12:00	Mc CALLUM Brian	LOCKE Bobby	CCTM K4	1
05/11/68	962	10:00	DAUBS Larry	ROETCISOENDER Bob	CCTM K3	2.7

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
10/11/68	970	11:30	DAUBS Larry	ROETCISOENDER Bob	CCTM K4	1.1
10/11/68	980	10:10	Mc CALLUM Brian	LOCKE Bobby	HABU	5.9
11/11/68	962	10:00	CAMPBELL Bill	PENNINGTON Al	CCTM K3	2.2
12/11/68	962	10:00	CAMPBELL Bobby	KRAUS Jon	CCTM K3	2.5
13/11/68	980	10:00	Mc CALLUM Brian	LOCKE Bobby	CCTM K3	2.4
15/11/68	962	10:30	DAUBS Larry	ROETCISOENDER Bob	CCTM K3	2.5
16/11/68	970	10:30	CAMPBELL Bobby	KRAUS Jon	CCTM K3	2.5
18/11/68	962	09:50	BOWLES Den	FAGG Jimmy	CCTM K3	2.3
21/11/68	980		DAUBS Larry	ROETCISOENDER Bob	HABU	
21/11/68	970	11:10	CAMPBELL Bobby	KRAUS Jon	HABU	5.9
22/11/68	962	09:30	DAUBS Larry	ROETCISOENDER Bob	HABU	5.9
23/11/68	980	10:35	BOWELS Ben	FAGG Jimmy	HABU	5.8
24/11/68	962	11:45	Mc CALLUM Brian	LOCKE Bobby	CCTM K4	1.1
26/11/68	962	14:15	CAMPBELL Bobby	KRAUS Jon	CCTM K3	2.5
27/11/68	970	11:55	Mc CALLUM Brian	LOCKE Bobby	CCTM K3	2.4
29/11/68	962	09:30	DAUBS Larry	ROETCISOENDER Bob	CCTM K3	0.0
30/11/68	962	09:30	BOWELS Ben	FAGG Jimmy	CCTM K3	2.5
02/12/68	980	12:45	DAUBS Larry	ROETCISOENDER Bob	HABU	4.1
03/12/68	962	10:00	CAMPBELL Bobby	KRAUS Jon	HABU	1.5
03/12/68	970	11:00	BOWELS Ben	FAGG Jimmy	HABU	3.7
04/12/68	980	10:45	SPENCER Bob	BRANHAM Keith	CCTM K4	0.9
04/12/68	962	09:30	CAMPBELL Bobby	KRAUS Jon	HABU	5.4
05/12/68	980	12:00	SPENCER Bob	BRANHAM Keith	HABU	1.7
07/12/68	980	10:00	DAUBS Larry	ROETCISOENDER Bob	CCTM K3	2.5
08/12/68	970	09:30	BOWELS Ben	FAGG Jimmy	CCTM K3	2.5
09/12/68	962	11:00	SPENCER Bob	BRANHAM Keith	HABU	5.3
10/12/68	970	11:50	DAUBS Larry	ROETCISOENDER Bob	HABU	5.4
10/12/68	980	13:06	CAMPBELL Bobby	KRAUS Jon	CCTM K3	1
11/10/68	962	10:55	CAMPBELL Bobby	KRAUS Jon	HABU	5.5
13/12/68	970	11:45	BOWELS Ben	FAGG Jimmy	HABU	5.7
13/12/68	980	13:00	SPENCER Bob	BRANHAM Keith	CCTM K4	1
17/12/68	970	10:00	LAWSON Willie	MARTINEZ Gil	CCTM K3	2.7
19/12/68	980	12:15	CAMPBELL Bobby	KRAUS Jon	CCTM K4	1.2
20/12/68	962	10:30	SPENCER Bob	BRANHAM Keith	HABU	5.7
21/12/68	980	10:00	BOWELS Ben	FAGG Jimmy	CCTM K3	2.1
24/12/68	970	10:00	LAWSON Willie	MARTINEZ Gil	HABU	6.2
27/12/68	970	10:00	POWELL Robert [Bob]	KENDRICK Bill	CCTM K3	2.5
29/12/68	980	11:50	POWELL Bob	KENDRICK Bill	HABU	3.8
30/12/68	962	11:35	BOWELS Bob	FAGG Jimmy	HABU	6.1
30/12/68	970	12:50	SPENCER Bob	BRANHAM Keith	CCTM K4	1
05/01/69	980	10:00	LAWSON Willie	MARTINEZ Gil	CCTM K3	2.5
06/01/69	962	10:00	POWELL Bob	KENDRICK Bill	CCTM K3	2.3
10/01/69	970	12:25	SPENCER Bob	BRANHAM Keith	HABU	4.2
10/01/69	980	13:41	LAWSON Willie	MARTINEZ Gil	CCTM K4	1.3
13/01/69	980	10:00	O'MALLEY Jerry	PAYNE Ed	CCTM K3	2.3
14/01/69	962	10:15	POWELL Bob	KENDRICK Bill	CCTM K3	2.2
16/01/69	980	10:10	SPENCER Bob	BRANHAM Keith	CCTM K3	2.4
18/01/69	970		LAWSON Willie	MARTINEZ Gil	CCTM	
20/01/69	980	12:00	POWELL Bob	KENDRICK Bill	CCTM K4	1.1
20/01/69	962	11:55	LAWSON Willie	MARTINEZ Gil	CCTM K3	2.3
21/01/69	970	09:55	O'MALLEY Jerry	PAYNE Ed	CCTM K3	2.3
23/01/69	962	12:30	LAWSON Willie	MARTINEZ Gil	CCTM K3	2.5
25/01/69	980	13:56	POWELL Bob	KENDRICK Bill	CCTM K4	1.2
26/01/69	970	09:30	KARDONG Abe	KOGLER Jim	CCTM K3	2.5
27/01/69	980	12:00	LAWSON Willie	MARTINEZ Gil	HABU	5.9
28/01/69	970	12:00	POWELL Bob	KENDRICK Bill	HABU	6
29/01/69	962	12:00	O'MALLEY Jerry	PAYNE Ed	HABU	5.3
31/01/69	980	10:00	KARDONG Abe	KOGLER Jim	FCF/S/K3	0.7
02/0/69	980	10:00	KARDONG Abe	KOGLER Jim	CCTM K3	2.4
03/02/69	980	10:15	LAWSON Willie	MARTINEZ Gil	CCTM K3	2.5
06/02/69	962	12:10	POWELL Bob	KENDRICK Bill	CCTM K3	2.3
07/02/69	980	10:15	O'MALLEY Jerry	PAYNE Ed	FCF/E/K3	2.6
08/02/69	970		FRUEHAUF Dave	PAYNE Al	CCTM K3	
11/02/69	980	10:55	FRUEHAUF Dave	PAYNE Al	FCF/E/K3	2.1
12/02/69	970	10:15	KARDONG Abe	KENDRICK Bill	CCTM K5	2
13/02/69	980	11:45	POWELL Bob	KOGLER Jim	FCF/E/K3	2.1
14/02/69	962	13:00	KARDONG Abe	KOGLER Jim	HABU	4.1
15/02/69	970	12:55	POWELL Bob	KENDRICK Bill	HABU	4.2
17/02/69	980	09:50	O'MALLEY Jerry	PAYNE Ed	FCF/E/K3	2.5
19/02/69	970		FRUEHAUF Dave	PAYNE Al	CCTM	
20/02/69	980	13:06	KARDONG Abe	PAYNE Al	CCTM K3	1.7
21/02/69	962	10:10	KARDONG Abe	KOGLER Jim	FCT/PHASE/K3	2.4
23/02/69	980	09:50	DEVALL Larry	SHOEMAKER Clyde	CCTM K5	2.4

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hou
25/02/69	970	10:30	O'MALLEY Jerry	PAYNE Ed	CCTM K3	0.4
26/02/69	962	10:30	FRUEHAUF Dave	PAYNE Al	CCTM K5	2.6
28/02/69	970	09:30	KARDONG Abe	KOGLER Jim	CCTM K3	2.5
03/03/69	962	09:30	DEVALL Larry	SHOEMAKER Clyde	CCTM K5	2.3
04/03/69	980	09:30	O'MALLEY Jerry	PAYNE Ed	FCF/PHASE/K3	2.5
06/03/69	980		FRUEHAUF Dave	PAYNE Al	CCTM K3	
07/03/69	980	10:15	FRUEHAUF Dave	PAYNE Al	CCTM K3	2.5
09/03/69	962	11:30	FRUEHAUF Dave	PAYNE Al	HABU	6.1
10/03/69	980	11:55	DEVALLL Larry	SHOEMAKER Clyde	HABY	5.3
11/03/69	970	11:00	BROWN Buddy	JARVIS Mort	FCS/PHASE/K4	1.2
12/03/69	962	11:00	KARDONG Abe	KOGLER Jim	HABU	5.2
13/03/69	962	11:35	KARDONG Abe	KOGLER Jim	RTB BERRY	0.7
14/03/69	980	13:00	BROWN Buddy	JARVIS Mort	CCTM K3	2.5
18/03/69	962	13:00	DEVALL Larry	SHOEMAKER Clyde	CCTM K4	1.2
18/03/69	970	12:20	FRUEHAUF Dave	PAYNE Al	CCTM K3	2.4
19/03/69	980	13:10	BROWN Buddy	JARVIS Mort	HABU	4.2
20/03/69	962	12:30	FRUEHAUF Dave	PAUNE Al	HABU	6
21/03/69	970		DEVALL Larry	SHOEMAKER Clyde	HABU	
21/03/69	980	13:50	KARDONG Abe	KOGLER Jim	HABU	4
25/03/69	962	11:40	HUDSON Jim	BUDZINSKI Norb	CCTM K3	2.4
26/03/69	970	13:00	DEVALL Larry	SHOEMAKER Clyde	HABU	5.3
27/03/69	980	13:05	BROWN Buddy	JARVIS Mort	HABU	4.2
27/03/69	962	14:40	HUDSON Jim	BUDZINSKI Norb	CCTM K3	2.3
01/04/69	980	11:00	FRUEHAUF Dave	PAYNE Al	CCTM K3	2.4
05/04/69	970	12:30	DEVALL Larry	SHOEMAKER Clyde	CCTM K3	1.3
06/04/69	962	11:30	HUDSON Jim	BUDZINSKI Norb	HABU	5.5
07/04/69	980	10:00	DEVALL Larry	SHOEMAKER Clyde	HABU	4.1
08/04/69	962	13:20	BROWN Buddy	JARVIS Mort	HABU	4.2
08/04/69	980	14:35	ESTES Tom	VICK Dewain	CCTM K3	2.4
09/04/69	970	11:40	ESTES Tom	VICK Dewain	HABU	0.9
09/04/69	962	12:40	HUDSON Jim	BUDZINSKI Norb	HABU	5.6
11/04/69	970	11:00	DEVALL Larry	SHOEMAKER Clyde	CCTM K3	1.6
13/04/69	962	10:00	BROWN Buddy	JARVIS Mort	CCTM K3	2.3
15/04/69	962	13:30	ESTES Tom	VICK Dewain	HABU	4.2
16/04/69	970		HUDSON Jim	BUDZINSKI Norb	CCTM	
17/04/69	970	11:00	HUDSON Jim	BUDZINSKI Norb	CCTM k4	1
18/04/69	971	03:00	BULL George	Mc NEER Red	FERRY TO OL-8	5.6
19/04/69	980	06:00	DEVALL Larry	SHOEMAKER Clyde	FERRY TO SC-5	
21/04/69	979	03:27	STORRIE John	MALLOZZIE Cos	FERRY TO OL-8	5.3
22/04/69	970	06:00	BULL George	Mc NEER Red	FERRY TO SC-5	
23/04/69	971	14:00	BROWN Buddy	JARVIS Mort	HABU	4.1
24/04/69	975	03:51	WATKINS Jim	LOIGNON Phil	FERRY TO OL-8	5.5
25/04/69	962	06:00	BROWM Buddy	JARVIS Mort	FERRY TO SC-5	
26/04/69	979	10:00	ESTES Tom	VICK Dewain	CCTM K3	1.8
29/04/69	975	10:30	HUDSON Jim	BUDZINSKI Norb	CCT3 K3	2.3
01/05/69	979	12:30	HUDSON Jim	BUDZINSKI Norb	HABU	0.7
01/05/69	971	13:30	ESTES Tom	VICK Dewain	HABU	5.2
02/05/69	975	10:15	STORRIE John	MALLOZZIE Cos	CCTM K3	2.4
04/05/69	979	10:30	WATKINS Jim	LOIGNON Phil	CCTM K3	2.4
09/05/69	975	11:06	HUDSON Jim	BUDZINSKI Norb	CCTM K5	2.3
10/05/69	979	13:35	HUDSON Jim	BUDZINSKI Norb	HABU	0.4
10/05/69	971	14:35	STORRIE John	MALLOZZIE Cos	HABU	0.7
11/05/69	975	13:00	HUDSON Jim	BUDZINSKI Norb	HABU	5.4
12/05/69	971	13:35	STORRIE John	MALLOZZIE Cos	HABU	4.2
14/05/69	971	13:35	WATKINS Jim	LOIGNON Phil	HABU	3.4
14/05/69	975	14:50	ESTES Tom	VICK Dewain	CCTM K3	2.4
16/05/69	971	14:00	WATKINS Jim	LOIGNON Phil	RTB FERRY	2.5
16/05/69	979	13:50	ESTES Tom	VICK Dewain	HABU	1.2
16/05/69	975	14:50	STORRIE John	MALLOZZIE Cos	HABU	2.2
18/05/69	971	13:50	ESTES Tom	VICK Dewain	HABU	4
18/05/69	975	15:05	STORRIE John	MALLOZZIE Cos	CCTM K3	2.3
20/05/69	979	11:15	WATKINS Jim	LOIGNON Phil	CCTM K5	0.7
20/05/69	975	10:00	SHELTON Jim	SCHMITTOU Tom	CCTM K3	2.5
21/05/69	979	13:20	WATKINS Jim	LOIGNON Phil	CCTM K5	2.4
22/05/69	975	12:40	STORRIE John	MALLOZZIE Cos	HABU	5.1
23/05/69	971	10:15	ESTES Tom	VICK Dewain	CCTM K3	2.4
24/05/69	979	10:00	WATKINS Jim	LOIGNON Phil	HABU	3.5
25/05/69	975	13:00	SHELTON Jim	SCHMITTOU Tom	HABU	5.4
26/05/69	979	10:00	STORRIE John	MALLOZZIE Cos	CCTM K3	2.3
28/05/69	979	09:05	ESTES Tom	VICK Dewain	HABU	5.9
29/05/69	971	09:30	STORRIE John	MALLOZZIE Cos	HABU	4.1
31/05/69	975	10:00	ST MARTIN Roy	BREADEN Cecil	CCTM K3	2.5
03/06/69	975	11:00	WATKINS Jim	LOIGNON Phil	CCTM K3	2.4
04/06/69	979	10:15	SHELTON Jim	SCHMITTOU Tom	CCTM K3	2.3
05/06/69	971		SHELTON Jim	SCHMITTOU Tom	HABU	
05/06/69	975	13:55	WATKINS Jim	LOIGNON Phil	HABU	5.6
07/06/69	975	09:05	WATKINS Jim	LOIGNON Phil	RTB FERRY	1.2
10/06/69	975	10:15	STORRIE John	MALLOZZIE Cos	CCTM K3	2.3
11/06/69	971	10:48	ST MARTIN Roy	BREADEN Cecil	CCTM K3	2.3
13/06/69	979	12:50	SHELTON Jim	SCHMITTOU Tom	HABU	1.3
13/06/69	975	13:50	ST MARTIN Roy	BREADEN Cecil	HABU	5.4
17/06/69	975	10:01	BULL George	Mc NEER Red	CCTM K3	1.3

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
8/06/69	975	14:15	STORRIE John	MALLOZZIE Cos	CCTM K3	2.3
12/06/69	979	09:46	ST MARTIN Roy	BREADEN Cecil	CCTM K3	2.3
13/06/69	971	10:15	SHELTON Jim	SCHMITTOU Tom	CCTM K3	2.3
25/06/69	975		BULL George	Mc NEER Red	CCTM K3	
29/06/69	975		STORRIE John	MALLOZZIE Cos	HABU	
29/06/69	971	09:45	BULL George	Mc NEER Red	CCTM K3	1.6
30/06/69	979	09:15	ST MARTIN Roy	BREADEN Cecil	HABU	3.5
1/07/69	975	10:00	STORRIE John	MALLOZZIE Cos	CCTM K4	0.4
12/07/69	979	12:30	STORRIE John	MALLOZZIE Cos	HABU	0.8
14/07/69	975		Mc CALLUM Brian	LOCKE Bobby	CCTM	
14/07/69	971	10:00	SHELTON Jim	SCHMITTOU Tom	CCTM K3	2.5
15/07/69	971	14:00	SHELTON Jim	SCHMITTOU Tom	HABU	4.1
16/07/69	975	10:10	Mc CALLUM Brian	LOCKE Bobby	CCTM K3	2.6
18/07/69	979	10:10	ST MARTIN Roy	BREADEN Cecil	HABU	3.5
18/07/69	975	09:10	BULL George	Mc NEER Red	HABU	1.5
10/07/69	971		Mc CALLUM Brian	LOCKE Bobby	CCTM	
11/07/69	971	10:40	Mc CALLUM Brian	LOCKE Bobby	CCTM K3	2.4
12/07/69	975	10:15	CAMPBELL Bobby	KRAUS Jon	CCTM K3	2.5
15/07/69	971	10:10	BULL George	Mc NEER Red	CCTM K3	2.4
18/07/69	979	10:20	ST MARTIN Roy	BREADEN Cecil	CCTM K3	2.3
18/07/69	975	09:30	Mc CALLUM Brian	LOCKE Bobby	CCTM K3	2.5
21/07/69	971	10:47	CAMPBELL Bobby	KRAUS Jon	CCTM K4	1.1
22/07/69	979	10:30	ST MARTIN Roy	BREADEN Cecil	CCTM K3	1.6
23/07/69	975	13:30	BULL George	Mc NEER Red	HABU	5.8
25/07/69	979	09:45	Mc CALLUM Brian	LOCKE Bobby	CCTM K3	2.4
26/07/69	971	09:45	DAUBS Larry	ROETCISOENDER Bob	FCF K3	2.4
28/07/69	979	12:45	Mc CALLUM Brian	LOCKE Bobby	HABU	5.7
30/07/69	971	10:17	CAMPBELL Bobby	KRAUS Jon	FCF K3	2.3
01/08/69	975	10:00	BULL George	Mc NEER Red	FCF K4	1.2
03/08/69	971		CAMPBELL Bobby	KRAUS Jon	FCF K4	
03/08/69	975	14:50	DAUBS Larry	ROETCISOENDER Bob	HABU	4.2
04/08/69	979	09:45	CAMPBELL Bobby	KRAUS Jon	HABU	4.8
09/08/69	971	10:00	Mc CALLUM Brian	LOCKE Bobby	FCF K3	1.9
11/08/69	979	10:00	DAUBS Larry	ROETCISOENDER Bob	FCF K3	2.4
13/08/69	979		BOWLES Ben	FAGG Jimmy	FCF K3	
14/08/69	975	10:00	BOWLES Ben	FAGG Jimmy	CCTM K3	2.6
15/08/69	979	12:05	CAMPBELL Bobby	KRAUS Jon	FCF K4	1.2
16/08/69	971	12:00	Mc CALLUM Brian	LOCKE Bobby	HABU	3.6
18/08/69	979		DAUBS Larry	ROETCISOENDER Bob	FCF	
22/08/69	979	12:00	DAUBS Larry	ROETCISOENDER Bob	FCF K3	2.3
23/08/69	975	12:35	DAUBS Larry	ROETCISOENDER Bob	HABU	5.4
24/08/69	971	13:35	BOWLES Ben	FAGG Jimmy	HABU	4
25/08/69	975	11:00	CAMPBELL Bobby	KRAUS Jon	FCF K3	2.4
27/08/69	971	10:00	POWELL Bob	COLEMAN Gary	FCF K3	2.4
31/08/69	979		CAMPBELL Bobby	KRAUS Jon	HABU	
31/08/69	975	14:30	POWELL Bob	COLEMAN Gary	HABU	4
03/09/69	979		DAUBS Larry	ROETCISOENDER Bob	FCF	
04/09/69	979	10:00	DAUBS Larry	ROETCISOENDER Bob	FCF K3	2.3
06/09/69	975	14:35	BOWLES Ben	FAGG Jimmy	CCTM K4	1.1
08/09/69	971	13:20	DAUBS Larry	ROETCISOENDER Bob	HABU	4.1
09/09/69	979	13:20	BOWLES Ben	FAGG Jimmy	HABU	4.3
10/09/69	975	13:15	LAWSON Willie	MARTINEZ Gil	HABU	2.1
10/09/69	971	14:20	POWELL Bob	COLEMAN Gary	HABU	4.1
12/09/69	971		BOWLES Ben	FAGG Jimmy	FCF	
15/09/69	979	12:30	LAWSON Willie	MARTINEZ Gil	HABU	5.4
15/09/69	971	13:30	BOWLES Ben	FAGG Jimmy	K7	2.5
16/09/69	975	11:20	DAUBS Larry	ROETCISOENDER Bob	HABU	5.7
18/09/69	975	10:00	POWELL Bob	COLEMAN Gary	FCF K3	2.2
19/09/69	971	10:00	BOWLES Ben	FAGG Jimmy	HABU	1.4
19/09/69	979	11:00	POWELL Bob	COLEMAN Gary	HABU	3.7
21/09/69	974	03:00	BEVACQUA Tony	KOGLER Jim	FERRY TO OL-8	2.9
24/09/69	969	09:00	SHELTON Jim	SCHMITTOU Tom	FERRY TO OL-8	5.4
25/09/69	979	06:00	BOWLES Ben	FAGG Jimmy	FERRY OUT	
27/09/69	973	02:00	FRUEHAUF Dave	PAYNE Al	FERRY TO OL-8	5.2
28/09/69	971	06:00	SHELTON Jim	SCHMITTOU Tom	FERRY TO SC-5	2.7
29/09/69	971	13:00	SHELTON Jim	SCHMITTOU Tom	FCF K3	2.2
29/09/69	969	11:40	LAWSON Willie	MARTINEZ Gil	HABU	5.3
30/09/69	972	09:00	SPENCER Bob	SHEFFIELD Butch	FERRY TO OL-8	5.3
01/10/69	971	06:00	SHELTON Jim	SCHMITTOU Tom	FERRY OUT	
03/10/69	974	02:17	BEVACQUA Tony	KOGLER Jim	FERRY TO OL-8	2.9
03/10/69	973	12:30	POWELL Bob	COLEMAN Gary	HABU	4.5
04/10/69	973	09:45	FRUEHAUF Dave	PAYNE Al	HABU	1.6

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
04/10/69	972	10:45	SPENCER Bob	SHEFFIELD Butch	HABU	6
08/10/69	969	10:00	LAWSON Willie	MARTINEZ Gil	K3	2.5
08/10/69	973	11:01	POWELL Bob	COLEMAN Gary	K7	2.4
09/10/69	973	10:00	FRUEHAUF Dave	PAYNE Al	HABU	3.8
10/10/69	969	10:00	SPENCER Bob	SHEFFIELD Butch	K3	1.6
12/10/69	972		LAWSON Willie	MARTINEZ Gil	HABU	
12/10/69	973	11:30	POWELL Bob	COLEMAN Gary	HABU	5.6
13/10/69	969	10:15	LAWSON Willie	MARTINEZ Gil	K7	2.4
17/10/69	972	10:20	LAWSON Willie	MARTINEZ Gil	HABU	3.7
20/10/69	972		FRUEHAUF Dave	PAYNE Al	K3	
20/10/69	969	11:00	FRUEHAUF Dave	PAYNE Al	K7	2.5
22/10/69	975	06:00	DAUBS Larry	ROETCISOENDER Bob	FERRY OUT	
22/10/69	972	10:00	DEVALL Larry	SHOEMAKER Clyde	K3	2.5
22/10/69	973	11:00	SPENCER Bob	SHEFFIELD Butch	K7	2.5
24/10/69	969	10:15	LAWSON Willie	MARTINEZ Gil	K7	2.5
27/10/69	972	10:00	FRUEHAUF Dave	PAYNE Al	K3	2.4
29/10/69	969	09:50	LAWSON Willie	MARTINEZ Gil	K3	2.4
31/10/69	973	10:30	DEVALL Larry	SHOEMAKER Clyde	K3	2.3
31/10/69	972	10:30	SPENCER Bob	SHEFFIELD Butch	K3	2.3
03/11/69	972	10:00	HUDSON Jim	BUDZINSKI Norb	K3	2.2
06/11/69	973	12:20	SPENCER Bob	SHEFFIELD Butch	HABU	4.1
07/11/69	974	10:05	FRUEHAUF Dave	PAYNE Al	K7	2.4
09/11/69	973	12:00	DEVALL Larry	SHOEMAKER Clyde	HABU	4.2
10/11/69	974	09:55	HUDSON Jim	BUDZINSKI Norb	K3	2.4
11/11/69	969	12:00	FRUEHAUF Dave	PAYNE Al	HABU	4.2
13/11/69	973	09:45	SPENCER Bob	SHEFFIELD Butch	K3	2.4
16/11/69	972	10:00	ESTES Tom	VICK Dewin	K3	2.3
22/11/69	974	11:00	SPENCER Bob	SHEFFIELD Butch	HABU	1.4
22/11/69	972	13:30	DEVALL Larry	SHOEMAKER Clyde	K3	2.3
23/11/69	974	16:03	SPENCER Bob	SHEFFIELD Butch	RTB FERRY	1.5
24/11/69	969		HUDSON Jim	BUDZINSKI Norb	K3	
26/11/69	973	11:00	HUDSON Jim	BUDZINSKI Norb	HABU	4
27/11/69	969	11:15	ESTES Tom	VICK Dewain	K3	2.3
27/11/69	972	10:00	DEVALL Larry	SHOEMAKER Clyde	HABU	5.2
28/11/69	969	11:00	ESTES Tom	VICK Dewain	HABU	6
01/12/69	974	10:50	BROWN Buddy	JARVIS Mort	K7	2.4
03/12/69	972	10:00	HUDSON Jim	BUDZINSKI Norb	K3	2.3
03/12/69	974	11:00	DEVALL Larry	SHOEMAKER Clyde	K3	2.5
05/12/69	969	10:30	HUDSON Jim	BUDZINSKI Norb	HABU	5.6
06/12/69	974	10:19	ESTES Tom	VICK Dewain	K7	2.4
08/12/69	974	10:15	BROWN Buddy	JARVIS Mort	K3	2.2
09/12/69	972	10:15	DEVALL Larry	SHOEMAKER Clyde	K3	2.1
11/12/69	973	10:10	HUDSON Jim	BUDZINSKI Norb	K3	2.3
12/12/09	974	10:20	BROWN Buddy	JARVIS Mort	HABU	5.2
15/12/69	969	10:15	ESTES Tom	VICK Dewain	K3	2.4
16/12/69	973	10:00	SHELTON Jim	SCHMITTOU Tom	K3	1.4
17/12/69	974	10:15	HUDSON Jim	BUDZINSKI Norb	K3	2.3
19/12/69	973	10:00	SHELTON Jim	SCHMITTOU Tom	K3	2.4
20/12/69	972	10:15	BROWN Buddy	JARVIS Mort	K3	2.3
22/12/69	972	10:15	HUDSON Jim	BUDZINSKI Norb	K7	2.3
23/12/69	974	12:10	ESTES Tom	VICK Dewain	HABU	2.1
23/12/69	973	13:10	SHELTON Jim	SCHMITTOU Tom	HABU	4.1
26/12/69	972	10:43	ST MARTIN Roy	BREADEN Cecil	K7	2.3
29/12/69	972	10:30	ESTES Tom	VICK Dewain	HABU	5.8
30/12/69	969	09:55	BROWN Buddy	JARVIS Mort	K8	2
01/01/70	972	12:20	BROWN Buddy	JARVIS Mort	HABU	4
02/01/70	973	12:05	SHELTON Jim	SCHMITTOU Tom	K3	2.2
06/01/70	972	10:15	ESTES Tom	VICK Dewain	K3	2.4
06/01/70	969	11:15	ST MARTIN Roy	BREADEN Cecil	K3	2.3
07/01/70	972	10:15	BROWN Buddy	JARVIS Mort	K3	2.3
09/01/70	972	11:10	SHELTON Jim	SCHMITTOU Tom	HABU	5.3
12/01/70	974	10:15	BULL George	KRAUS Jon	K3	2.3
13/01/70	909	10:15	ST MARTIN Roy	BREADEN Cecil	K7	2.3
15/01/70	972	11:53	ST MARTIN Roy	BREADEN Cecil	HABU	3.9
16/01/70	974	14:20	SHELTON Jim	SCHMITTOU Tom	K3	2.3
19/01/70	972	10:15	BROWN Buddy	JARVIS Mort	K11	2.1
20/01/70	969	10:15	BULL George	KRAUS Jon	K11	2.2
21/01/70	974	10:15	ST MARTIN Roy	BREADEN Cecil	K3	2.3
24/01/70	974	12:58	STORRIE John	MALLOZZIE Cos	K3	2.3
28/01/70	972	10:15	SHELTON Jim	SCHMITTOU Tom	K3	2.4
28/01/70	969	11:15	BULL George	KRAUS Jon	K7	2.3
29/01/70	973	12:55	ST MARTIN Roy	BREADEN Cecil	K3	1.3
29/01/70	974	11:35	BULL George	KRAUS Jon	HABU	5.5
01/02/70	973	12:45	STORRIE John	MALLOZZIE Cos	K3	2.3
03/02/70	969	11:30	SHELTON Jim	SCHMITTOU Tom	HABU	1.4
03/02/70	974	12:30	ST MARTIN Roy	BREADEN Cecil	HABU	5.5
04/02/70	973	10:15	BULL George	KRAUS Jon	K7	2.4
07/02/70	969	10:15	POWELL Bob	COLEMAN Gary	K3	2.4
08/02/70	969	11:50	STORRIE John	MALLOZZIE Cos	HABU	5.6
09/02/70	974	10:15	ST MARTIN Roy	BREADEN Cecil	K10	2.2
11/02/70	972	10:15	BULL George	KRAUS Jon	K11	2.4

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
13/02/70	972	10:15	POWELL Bob	COLEMAN Gary	K11	2.3
14/02/70	973	10:02	STORRIE John	MALLOZZIE Cos	K11	2.3
16/02/70	973	10:00	ST MARTIN Roy	BREADEN Cecil	HABU	2.6
18/02/70	974	11:55	BULL George	KRAUS Jon	K3	2.3
19/02/70	972	10:14	POWELL Bob	COLEMAN Gary	K7	2.4
20/02/70	973	12:00	STORRIE John	MALLOZZIE Cos	K3	2.2
21/02/70	972	12:00	BEVACQUA Tony	KOGLER Jim	K3	2.3
23/02/70	974	09:45	BULL George	KRAUS Jon	K7	2.4
25/02/70	974	12:00	BULL George	KRAUS Jon	HABU	5.6
28/02/70	972	10:10	POWELL Bob	COLEMAN Gary	K11	2.2
02/03/70	973	10:15	STORRIE John	MALLOZZIE Cos	K11	2.5
04/03/70	973	11:50	BEVACQUA Tony	KOGLER Jim	K7	2.4
06/03/70	973	10:24	POWELL Bob	COLEMAN Gary	K7	2.3
08/03/70	974	10:15	Mc CALLUM Brian	LOCKE Bobby	K11	2.4
09/03/70	969	10:15	STORRIE John	MALLOZZIE Cos	K11	2.4
11/03/70	973	11:00	BEVACQUA Tony	KOGLER Jim	K3	1.4
12/03/70	969	10:14	POWELL Bob	COLEMAN Gary	K7	2.5
14/03/70	972	11:00	BEVACQUA Tony	KOGLER Jim	K11	2.4
14/03/70	973	10:00	Mc CALLUM Brian	LOCKE Bobby	K3	2.3
19/03/70	969	09:26	POWELL Bob	COLEMAN Gary	HABU	5.3
20/03/70	972	13:25	BEVACQUA Tony	KOGLER Jim	K11	2.6
22/03/70	972	10:15	BOWELS Ben	FAGG Jimmy	K3	2.5
22/03/70	969	11:15	Mc CALLUM Brian	LOCKE Bobby	K11	2.5
24/03/70	972	10:15	POWELL Bob	COLEMAN Gary	K11	2.3
25/03/70	973	10:15	BEVACQUA Tony	KOGLER Jim	K11	1.5
30/03/70	973	11:50	Mc CALLUM Brain	LOCKE Bobby	K7	2.5
31/03/70	972	10:15	BOWELS Ben	FAGG Jimmy	K3	2.4
03/04/70	972	11:20	BEVACQUA Tony	KOGLER Jim	HABU	5.7
04/04/70	969	10:15	LAWSON Willie	MARTINEZ Gil	K11	2.4
06/04/70	972	10:15	Mc CALLUM Brian	LOCKE Bobby	K11	2.4
09/04/70	969	12:00	Mc CALLUM Brian	LOCKE Bobby	HABU	5.5
10/04/70	973	12:00	BOWELS Ben	FAGG Jimmy	HABU	5.3
12/04/70	972		BEVACQUA Tony	KOGLER Jim	K7	
12/04/70	973	11:30	LAWSON Willie	MARTINEZ Gil	K11	2.2
13/04/70	972	10:15	BEVACQUA Tony	KOGLER Jim	K7	2.4
17/04/70	972	10:00	Mc CALLUM Brian	LOCKE Bobby	K7	2.4
19/04/70	972	10:15	FRUEHAUF Dave	PAYNE Al	K3	2.2
19/04/70	973	11:15	BOWLES Ben	FAGG Jimmy	K11	2.4
21/04/70	974	12:15	LAWSON Willie	MARTINEZ Gil	K11	2.5
22/04/70	969		Mc CALLUM Brian	LOCKE Bobby	K7	
23/04/70	974	12:15	BOWLES Ben	FAGG Jimmy	K3	2.4
23/04/70	969	11:15	FRUEHAUF Dave	PAYNE Al	K7	2.3
25/04/70	969	10:15	DEVALL Larry	SHOEMAKER Clyde	K11	2.4
26/04/70	974	10:22	BOWLES Ben	FAGG Jimmy	HABU	1.8
26/04/70	973	11:43	LAWSON Willie	MARTINEZ Gil	HABU	5.4
28/04/70	974		FRUEHAUF Dave	PAYNE Al	K3	
29/04/70	974	10:15	FRUEHAUF Dave	PAYNE Al	K3	2.5
30/04/70	973	10:10	DEVALL Larry	SHOEMAKER Clyde	K7	2.4
01/05/70	969	12:10	LAWSON Willie	MARTINEZ Gil	HABU	5.5
02/05/70	973	12:05	BOWLES Ben	FAGG Jimmy	HABU	5.5
04/05/70	969	10:15	FRUEHAUF Dave	PAYNE Al	K3	2.4
05/05/70	973	10:15	DEVALL Larry	SHOEMAKER Clyde	K3	2.3
06/05/70	974	08:30	FRUEHAUF Dave	PAYNE Al	HABU	4.2
07/05/70	969	10:50	BOWLES Ben	FAGG Jimmy	HABU	3.6
08/05/70	972	10:15	LAWSON Willie	MARTINEZ Gil	K3	2.3
09/05/70	973	12:10	DEVALL Larry	SHOEMAKER Clyde	HABU	5.4
10/05/70	969	10:30	LAWSON Willie	MARTINEZ Gil	HABU	
CRASH.7						
17/05/70	974	10:15	SPENCER Bob	SHEFFIELD Butch	K7	2.5
18/05/70	973	10:45	FRUEHAUF Dave	PAYNE Al	K3	2.3
19/05/70	972	10:15	BOWLES Ben	FAGG Jimmy	K3	2.3
21/05/70	973	10:15	DEVALL Larry	SHOEMAKER Clyde	K3	2.3
23/05/70	974	10:15	HUDSON Jim	BUDZINSKI Norb	K3	2.3
25/05/70	972		SPENCER Bob	SHEFFIELD Butch	K7	
29/05/70	972	10:15	SPENCER Bob	SHEFFIELD Butch	K7	2.2
02/06/70	972	12:11	HUDSON Jim	BUDZINSKI Norb	K7	1.1
02/06/70	974	13:10	FRUEHAUF Dave	PAYNE Al	HABU	4.1
03/06/70	972	12:10	DEVALL Larry	SHOEMAKER Clyde	K3	2.3
05/06/70	974	10:50	FRUEHAUF Dave	PAYNE Al	HABU	3.6
06/06/70	973	14:50	SPENCER Bob	SHEFFIELD Butch	K3	2.3
06/06/70	972	13:30	DEVALL Larry	SHOEMAKER Clyde	HABU	4
09/06/70	974	10:35	HUDSON Jim	BUDZINSKI Norb	K7	2.4
10/06/70	972		FRUEHAUF Dave	PAYNE Al	K7	
11/06/70	972	10:00	FRUEHAUF Dave	PAYNE Al	K4	1.1
15/06/70	973	12:00	SPENCER Bob	SHEFFIELD Butch	HABU	4.1
17/06/70	973	12:15	HUDSON Jim	BUDZINSKI Norb	HABU	5.8
17/06/70	972	13:15	ESTES Tom	VICK Dewain	K7	2.4
26/06/70	974	11:00	SPENCER Bob	SHEFFIELD Butch	HABU	5
12/07/70	972	11:04	ESTES Tom	VICK Dewain	K4	0.9
12/07/70	973	11:15	HUDSON Jim	BUDZINSKI Norb	K4	1.3
14/07/70	973		SPENCER Bob	SHEFFIELD Butch	K4	
14/07/70	974	10:10	STORRIE John	MALLOZZIE Cos	K4	1.2
14/07/70	973	13:30	SPENCER Bob	SHEFFIELD Butch	K4	1.2

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Ho
15/07/70	972	11:24	ESTES Tom	VICK Dewain	K4	1.3
15/07/70	973	12:21	HUDSON Jim	BUDZINSKI Norb	K4	1.3
17/07/70	973	10:30	STORRIE John	MALLOZZIE Cos	K4	1.2
18/07/70	972	10:05	SHELTON Jim	SCHMITTOU Tom	K4	1.1
20/07/70	972	16:01	HUDSON Jim	BUDZINSKI Norb	K4	1.1
21/07/70	974	10:00	STORRIE John	MALLOZZIE Cos	K4	1
22/07/70	973	10:00	ESTES Tom	VICK Dewain	HABU	2
22/07/70	972	11:39	SHELTON Jim	SCHMITTOU Tom	K4	1.1
22/07/70	974	11:00	HUDSON Jim	BUDZINSKI Norb	HABU	1.6
25/07/70	974		STORRIE John	MALLOZZIE Cos	HABU	
25/07/70	972	10:00	STORRIE John	MALLOZZIE Cos	HABU	2.1
26/07/70	973	10:04	COBB Darryl	GANTT Myron	K4	1.2
27/07/70	972	10:15	SHELTON Jim	SCHMITTOU Tom	K7	2.4
28/07/70	974	09:10	ESTES Tom	VICK Dewain	HABU	0.7
28/07/70	972	10:10	STORRIE John	MALLOZZIE Cos	HABU	1.8
31/07/70	973	13:15	COBB Darryl	GANTT Myron	K3	2.3
31/07/70	974	11:50	ESTES Tom	VICK Dewain	HABU	5.8
05/08/70	972	09:45	STORRIE John	MALLOZZIE Cos	K4	0.9
05/08/70	974	10:00	SHELTON Jim	SCHMITTOU Tom	K4	1.1
06/08/70	973	09:50	COBB Darryl	GANTT Myron	K4	1.1
08/08/70	974	10:15	BULL George	KRAUS Jon	K3	2.3
10/08/70	972	10:30	STORRIE John	MALLOZZIE Cos	K7	1.5
11/08/70	974		SHELTON Jim	SCHMITTOU Tom	K3	
15/08/70	972	11:15	SHELTON Jim	SCHMITTOU Tom	K3	2.3
16/08/70	974	09:45	COBB Darryl	GANTT Myron	K3	2.3
17/08/70	973	12:00	BULL George	KRAUS Jon	K7	2.3
19/08/70	972	09:45	STORRIE John	MALLOZZIE Cos	K3	2.4
21/08/70	973	09:45	COBB Darryl	GANTT Myron	K9	2.4
21/08/70	974	11:15	BULL George	KRAUS Jon	K7	2.3
22/08/70	972	10:00	ST MARTIN Roy	BREADEN CECIL	K7	2.6
24/08/70	974	09:45	COBB Darryl	GANTT Myron	K9	2.4
25/08/70	974		BULL George	KRAUS Jon	K3	
25/08/70	973	10:00	STORRIE John	MALLOZZIE Cos	K3	2.2
26/08/70	974	09:45	BULL George	KRAUS Jon	K3	2.1
30/08/70	973	13:10	STORRIE John	MALLOZZIE Cos	HABU	4.1
01/09/70	974	09:45	ST MARTIN Roy	BREADEN Cecil	K9	2.3
02/09/70	972	11:42	COBB Darryl	GANTT Myron	K9	2.3
02/09/70	973	12:50	COBB Darryl	GANTT Myron	HABU	4.1
08/09/70	972	11:00	BROWN Buddy	JARVIS Mort	HABU	4.1
09/09/70	972	11:45	BULL George	KRAUS Jon	HABU	2.9
11/09/70	974	10:00	ST MARTIN Roy	DREADEN Cecil	K9	2.2
11/09/70	972	10:32	BULL George	KRAUS Jon	RTB FERRY	0.3
13/09/70	972	15:35	BULL George	KRAUS Jon	RTB FERRY	2.6
14/09/70	974	13:05	COBB Darryl	GANTT Myron	K9	2.4
17/09/70	973	11:30	ST MARTIN Roy	BREADEN Cecil	HABU	5.5
18/09/70	974	10:00	BULL George	KRAUS Jon	HABU	1.5
19/09/70	973	09:10	BULL George	KRAUS Jon	HABU	5
20/09/70	972	10:00	BROWN Buddy	JARVIS Mort	K7	2.3
21/09/70	972	09:30	POWELL Bob	COLEMAN Gary	HABU	3.5
23/09/70	973	11:30	BROWN Buddy	JARVIS Mort	HABU	4.2
24/09/70	974	10:15	ST MARTIN Roy	BREADEN Cecil	K9	2.4
26/09/70	972	12:00	ST MARTIN Roy	BREADEN Cecil	HABU	3.5
28/09/70	972	10:23	BULL George	KRAUS Jon	K7	1.4
30/09/70	974	10:15	POWELL Bob	COLEMAN Gary	K9	2.2
01/10/70	972	10:00	BROWN Buddy	JARVIS Mort	K9	2.3
03/10/70	974	10:00	ST MARTIN Roy	BREADEN Cecil	HABU	5.5
06/10/70	974	13:00	BEVACQUA Tohy	KOGLER Jim	HABU	1.6
07/10/70	973	11:00	BROWN Buddy	JARVIS Mort	HABU	5.4
08/10/70	972	09:45	POWELL Bob	COLEMAN Gary	K9	2.2
10/10/70	972	10:00	ST MARTIN Roy	BREADEN Cecil	K9	2.4
12/10/70	972		BEVACQUA Tony	KOGLER Jim	K9	
13/10/70	972	09:45	BEVACQUA Tony	KOGLER Jim	K9	2.4
13/10/70	974	11:00	BROWN Buddy	JARVIS Mort	K9	2.3
15/10/70	974	07:00	POWELL Bob	COLEMAN Gary	HABU	1.7
19/10/70	973	10:15	FRUEHAUF Dave	PAYNE Al	K3	2.5
22/10/70	972		BEVACQUA Tony	KOGLER Jim	K9	
23/10/70	973	12:15	POWELL Bob	COLEMAN Gary	HABU	4.1
24/10/70	972		FRUEHAUF Dave	PAYNE Al	HABU B/U	
24/10/70	974	11:15	BEVACQUA Tony	KOGLER Jim	HABU	5.5
26/10/70	972	10:00	BROWN Buddy	JARVIS Mort	K7	2.4
27/10/70	973	10:45	FRUEHAUF Dave	PAYNE Al	HABU	1.6
28/10/70	974	10:15	POWELL Bob	COLEMAN Gary	K7	2.3
31/10/70	974	11:30	BOWLES Ben	FAGG Jimmy	HABU	2
31/10/70	973	12:30	BEVACQUA Tony	KOGLER Jim	HABU	3.6
02/11/70	972	11:15	POWELL Bob	COLEMAN Gary	HABU	5.1
02/11/70	974	12:30	BEVACQUA Tony	KOGLER Jim	K9	2.3
04/11/70	974	10:50	BEVACQUA Tony	KOGLER Jim	HABU	5.6
05/11/70	974	11:00	FRUEHAUF Dave	PAYNE Al	HABU	1.7
06/11/70	973	12:10	BOWLES Ben	FAGG Jimmy	K9	2.3
06/11/70	974	10:50	FRUEHAUF Dave	PAYNE Al	HABU	5.6
09/11/70	972	10:00	POWELL Bob	COLEMAN Gary	K7	2.4
11/11/70	973	09:45	BEVACQUA Tony	KOGLER Jim	HABU	1.5
11/11/70	974	12:30	FRUEHAUF Dave	PAYNE Al	K7	2.5

ate	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
3/11/70	972	10:50	BOWLES Ben	FAGG Jimmy	HABU	5.4
5/11/70	973	10:15	PUGH Tom	RICE Ron	K3	2.5
3/11/70	974	11:30	PUGH Tom	RICE Ron	HABU	4.2
0/11/70	972	08:25	REVACQUA Tony	KOGLER Jim	HABU	5.5
0/11/70	974	13:35	PUGH Tom	RICH Ron	RTB FERRY	2.4
1/11/70	973	09:20	FRUEHAUF Dave	PAYNE Al	HABU	3.5
4/11/70	974	10:15	BOWLES Ben	FAGG Jimmy	K7	2.4
5/11/70	972	08:17	BOWLES Ben	FAGG Jimmy	HABU	3.6
7/11/70	972	11:45	PUGH Tom	RICE Ron	K3	2.5
8/11/70	973	10:00	FRUEHAUF Dave	PAYNE Al	K7	2.4
9/11/70	974	12:29	PUGH Tom	RICE Ron	HABU	3.5
0/11/70	972	10:15	BUSH Denny	LOIGNON Phil	K7	2.4
3/12/70	974	10:00	BOWLES Ben	FAGG Jimmy	K3	0.7
4/12/70	974	13:15	BUSH Denny	FAGG Jimmy	K4	0.9
4/12/70	972	12:59	PUGH Tom	RICE Ron	HABU	1.7
4/12/70	973	11:53	FRUEHAUF Dave	PAYNE Al	HABU	1.8
7/12/70	973	10:30	BOWLES Ben	FAGG Jimmy	HABU	1.3
1/12/70	972	10:00	PUGH Tom	RICE Ron	K7	2.4
3/12/70	974	10:10	HUDSON Jim	BUDZINSKI Norb	K3	2.4
4/12/70	972	10:00	BUSH Denny	LOIGNON Phil	K3	2.3
6/12/70	973	10:00	BOWLES Ben	FAGG Jimmy	K3	2.5
8/12/70	975	10:00	SPENCER Bob	SHEFFIELD Butch	FERRY TO OL-8	5.7
8/12/70	972	12:00	PUGH Tom	RICE Ron	HABU	6.1
9/12/70	974	12:05	BUSH Denny	LOIGNON Phil	HABU	6
1/12/70	973	11:00	HUDSON Jim	BUDZINSKI Norb	HABU	3.6
3/12/70	974	10:00	SPENCER Bob	SHEFFIELD Butch	K3	2.3
4/12/70	973	10:00	PUGH Tom	RICE Ron	HABU	3.6
5/12/70	972	08:35	PUGH Tom	RICE Ron	HABU	1.5
5/12/70	974	10:18	PUGH Tom	RICE Ron	HABU	2.2
9/12/70	973	11:00	HUDSON Jim	BUDZINSKI Norb	HABU	1.8
9/12/70	972	12:00	SPENCER Bob	SHEFFIELD Butch	HABU	2.1
2/01/71	974	10:00	SPENCER Bob	SHEFFIELD Butch	K3	2.2
2/01/71	972	11:15	BUSH Denny	LOIGNON Phil	K9	2.3
3/01/71	973	12:20	HUDSON Jim	BUDZINSKI Norb	K3	2.3
3/01/71	972	11:00	PUGH Tom	RICE Ron	HABU	5.8
4/01/71	975	09:00	DUSH Denny	LOIGNON Phil	K7	2.4
4/01/71	974	08:09	SPENCER Bob	SHEFFIELD Butch	HABU	3.9
7/01/71	974	17:30	HUDSON Jim	BUDZINSKI Norb	K12	0.7
8/01/71	975	12:15	BUSH Denny	LOIGNON Phil	HABU	5.3
9/01/71	973	08:55	HUDSON Jim	BUDZINSKI Norb	HABU	3.9
9/01/71	975	14:14	SPENCER Bob	SHEFFIELD Butch	HABU	1.5
0/01/71	972	13:30	ESTES Tom	VICK Dewain	K3	2.6
1/01/71	975	13:00	BUSH Denny	LOIGNON Phil	K3	1.8
3/01/71	975	10:30	HUDSON Jim	BUDZINSKI Norb	HABU	3.7
3/01/71	973	13:40	ESTES Tom	VICK Dewain	K9	1
5/01/71	975	11:30	SPENCER Bob	SHEFFIELD Butch	HABU	3.7
5/01/71	973	14:30	ESTES Tom	VICK Dewain	K9	2.2
6/01/71	972	11:00	HUDSON Jim	BUDZINSKI Norb	HABU	3
8/01/71	972	12:00	HUDSON Jim	BUDZINSKI Norb	RTB FERRY	2.5
9/01/71	973	16:30	SPENCER Bob	SHEFFIELD Butch	K3	2.3
2/01/71	975	11:40	ESTES Tom	VICK Dewain	HABU	3.8
4/01/71	972	11:00	SHELTON Jim	SCHMITTOU Tom	K3	2.4
5/01/71	973	10:00	HUDSON Jim	BUDZINSKI Norb	K3	2.4
6/01/71	973	11:50	SPENCER Bob	SHEFFIELD Butch	HABU	3.8
1/01/71	975	16:15	ESTES Tom	VICK Dewain	NK3	2.3
1/02/71	974	10:00	SHELTON Jim	SCHMITTOU Tom	K9	2.3
2/02/71	975	10:00	HUDSON Jim	BUDZINSKI Norb	HABU	3.7
6/02/71	973	12:30	SPENCER Bob	SHEFFIELD Butch	HABU	1.5
6/02/71	972	13:30	ESTES Tom	VICK Dewain	HABU	1.8
7/02/71	973	11:15	SHELTON Jim	SCHMITTOU Tom	K7	0.8
7/02/71	974	10:00	COBB Darryl	GANTT Myron	K3	2.3
8/02/71	972	13:00	ESTES Tom	VICK Dewain	RTB FERRY OL-RK	1.5
0/02/71	974	11:00	SPENCER Bob	SHEFFIELD Butch	HABU	1.6
0/02/71	973	12:15	COBB Darryl	GANTT Myron	HABU	3.7
0/02/71	972	14:30	SHELTON Jim	SCHMITTOU Tom	K7	2.4
2/02/71	973	11:01	COBB Darryl	GANTT Myron	K7	2.3
3/02/71	972	10:00	ESTES Tom	VICK Dewain	K9	2.5
3/02/71	974	11:04	SPENCER Bob	SHEFFIELD Butch	RTB FERRY (OL-RK)	1.6
5/02/71	973	12:50	SHELTON Jim	SCHMITTOU Tom	HABU	4
5/02/71	974	14:30	COBB Darryl	GANTT Myron	K9	2.4
8/02/71	973	17:45	SHELTON Jim	SCHMITTOU Tom	NK4	1.2
9/02/71	974	10:00	ESTES Tom	VICK Dewain	K7	2.4
0/02/71	973	12:20	ESTES Tom	VICK Dewain	HABU	5.4
1/02/71	975	10:15	STORRIE John	MALLOZZIE Cos	FCF K9	2.4
3/02/71	974	12:30	SHELTON Jim	SCHMITTOU Tom	HABU	5.3
3/02/71	972	14:35	COBB Darryl	GANTT Myron	K7	1.4
5/02/71	973	10:45	COBB Darryl	GANTT Myron	HABU	3.8
5/02/71	972	12:45	ESTES Tom	VICK Dewain	K7	2.4
6/02/71	974	13:37	STORRIE John	MALLOZZIE Cos	HABU	1.8
6/02/71	973	14:40	SHELTON Jim	SCHMITTOU Tom	HABU	3.7
7/02/71	975	11:00	COBB Darryl	GANTT Myron	K9	2.3
1/03/71	974	12:00	ESTES Tom	VICK Dewain	HABU	5.2
1/03/71	972	18:00	STORRIE John	MALLOZZIE Cos	NK12	0.8

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
02/03/71	975	10:00	SHELTON Jim	SCHMITTOU Tom	K7	2.4
04/03/71	972	11:51	STORRIE John	MALLOZZIE Cos	HABU	3.7
05/03/71	975	12:15	COBB Darryl	GANTT Myron	K9	2.5
07/03/71	974	11:30	SHELTON Jim	SCHMITTOU Tom	HABU	3.9
07/03/71	975	14:00	BULL George	KRAUS Jon	K3	2.4
09/03/71	972		COBB Darryl	GANTT Myron	K9	
10/03/71	972	12:00	COBB Darryl	GANTT Myron	K9	1.7
12/03/71	974	11:35	BULL George	KRAUS Jon	HABU	4
12/03/71	973	13:30	STORRIE John	GANTT Myron	K9	2.3
14/03/71	975	09:30	SHELTON Jim	SCHMITTOU Tom	HABU	5.1
15/03/71	973	10:00	COBB Darryl	GANTT Myron	K7	2.4
16/03/71	974	10:15	BULL George	KRAUS Jon	K9	2.4
16/03/71	975	11:15	STORRIE John	SCHMITTOU Tom	K9	2.3
17/03/71	972	11:50	COBB Darryl	GANTT Myron	HABU	7.6
20/03/71	973	10:00	ST MARTIN Roy	BREADEN Cecil	K9	0.7
21/03/71	973	13:20	ST MARTIN Roy	DREADEN Cecil	K9	2.1
21/03/71	974	12:00	STORRIE John	MALLOZZIE Cos	HABU	3.9
24/03/71	975	12:10	BULL George	KRAUS Jon	HABU	4.2
25/03/71	974	10:00	COBB Darryl	GANTT Myron	HABU	3.5
27/03/71	975	12:00	ST MARTIN Roy	BREADEN Cecil	HABU	1.7
27/03/71	974	13:00	COBB Darryl	GANTT Myron	HABU	3.9
28/03/71	975	12:20	ST MARTIN Roy	BREADEN Cecil	HABU	5.1
29/03/71	973	12:10	STORRIE John	MALLOZZIE Cos	HABU	5.4
30/03/71	974	10:00	BULL George	KRAUS Jon	HABU	3.5
04/04/71	975	11:30	ST MARTIN Roy	BREADEN Cecil	HABU	1.7
04/04/71	974	12:30	STORRIE John	MALLOZZIE Cos	HABU	2.1
05/04/71	973	10:00	HERTZOG Randy	CARNOCHAN John	K7	1.6
06/04/71	975	13:10	STORRIE John	MALLOZZIE Cos	HABU	3.9
07/04/71	973	10:15	HERTZOG Randy	CARNOCHAN John	K7	2.1
09/04/71	972		STORRIE John	MALLOZZIE Cos	K9	
10/04/71	972	14:40	STORRIE John	MALLOZZIE Cos	K9	2.4
12/04/71	975	12:00	BULL George	KRAUS Jon	HABU	1.8
12/04/71	974	13:03	ST MARTIN Roy	BREADEN Cecil	HABU	2.5
12/04/71	972	13:49	HERTZOG Randy	CARNOCHAN John	K9	1.8
13/04/71	975	09:45	STORRIE John	MALLOZZIE Cos	K7	2.4
15/04/71	975	12:50	BULL George	KRAUS Jon	HABU	3.8
19/04/71	974	10:15	BROWN Buddy	JARVIS Mort	K9	2.4
20/04/71	972	10:15	HERTZOG Randy	CARNOCHAN John	K9	2.2
21/04/71	974	12:00	HERTZOG Randy	CARNOCHAN John	HABU	5.5
23/04/71	975	11:45	BULL George	KRAUS Jon	HABU	3.5
24/04/71	974		BROWN Buddy	JARVIS Mort	K3	
25/04/71	974	10:00	BROWN Buddy	JARVIS Mort	K3	2.2
28/04/71	972	11:30	ST MARTIN Roy	BREADEN Cecil	K3	2.2
29/04/71	974	11:30	HERTZOG Randy	CARNOCHAN John	HABU	3.4
30/04/71	975	09:30	BROWN Buddy	JARVIS Mort	HABU	1.7
30/04/71	972	11:36	ST MARTIN Roy	BREADEN Cecil	HABU	3.7
02/05/71	975	09:30	FRUEHAUF Dave	PAYNE Al	K7	2.5
03/05/71	973	10:00	BROWN Buddy	JARVIS Mort	K9	2.1
07/05/71	975	10:00	HERTZOG Randy	CARNOCHAN John	K9	2.4
08/05/71	972	12:00	ST MARTIN Roy	BREADEN Cecil	HABU	1.6
08/05/71	973	13:00	FRUEHAUF Dave	PAYNE Al	HABU	3.5
09/05/71	973	10:00	ST MARTIN Roy	BREADEN Cecil	HABU	5.8
09/05/71	972	11:15	HERTZOG Randy	CARNOCHAN John	K9	2.2
10/05/71	975	10:00	BROWN Buddy	JARVIS Mort	K9	2.2
11/05/71	972	13:45	HERTZOG Randy	CARNOCHAN John	HABU	3.9
12/05/71	975	09:45	ST MARTIN Roy	BREADEN Cecil	K9	1.5
14/05/71	973	11:00	FRUEHAUF Dave	PAYNE Al	HABU	2.3
15/05/71	974	10:00	POWELL Bob	COLEMAN Gary	K9	2.3
16/05/71	975	10:00	BROWN Buddy	JARVIS Mort	K9	2.1
17/05/71	972	11:30	HERTZOG Randy	CARNOCHAN John	HABU	3.3
18/05/71	974	10:00	FRUEHAUF Dave	PAYNE Al	K9	2.4
20/05/71	973	10:10	POWELL Bob	COLEMAN Gary	HABU	3.5
23/05/71	974	10:00	BROWN Buddy	JARVIS Mort	K9	2.2
24/05/71	973	10:00	HERTZOG Randy	CARNOCHAN John	K9	2.3
25/05/71	974	10:00	FRUEHAUF Dave	PAYNE Al	K9	2.3
25/05/71	973	10:00	POWELL Bob	COLEMAN Gary	K9	2.2
27/05/71	972	12:50	BROWN Buddy	JARVIS Mort	HABU	1.6
27/05/71	973	13:50	FRUEHAUF Dave	PAYNE Al	HABU	5.6
28/05/71	975	13:45	POWELL Bob	COLEMAN Gary	K9	2.3
28/05/71	974	12:30	BROWN Buddy	JARVIS Mort	HABU	5.5
29/05/71	972	13:00	HERTZOG Randy	CARNOCHAN John	HABU	3.4
01/06/71	973	09:45	FRUEHAUF Dave	PAYNE Al	K9	1
03/06/71	973	09:45	POWELL Bob	COLEMAN Gary	K9	2.4
04/06/71	972	09:45	BROWN Buddy	JARVIS Mort	K9	2.3
06/06/71	975	09:30	FRUEHAUF Dave	PAYNE Al	HABU	3.2
08/06/71	973	06:00	BROWN Buddy	JARVIS Mort	FERRY OUT	
10/06/71	968	03:00	BEVACQUA Tony	KOGLER Jim	FERRY TO OL-RK	5.3
11/06/71	972	06:00	HERTZOG Randy	CARNOCHAN John	FERRY OUT	
13/06/71	979	03:00	ESTES Tom	VICK Dewain	FERRY TO OL-RK	5.4
14/06/71	974	06:00	FRUEHAUF Dave	PAYNE Al	FERRY OUT	
14/06/71	968	07:30	POWELL Bob	COLEMAN Gary	K7	2.4
16/06/71	978	03:00	BOWLES Ben	FAGG Jimmy	FERRY TO OL-RK	5.3
16/06/71	968	10:30	POWELL Bob	COLEMAN Gary	HABU	3.9

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
17/06/71	975	06:00	ESTES Tom	VICK Dewain	FERRY OUT	
17/06/71	979	10:20	BEVACQUA Tony	KOGLER Jim	HABU	2.3
18/06/71	978	10:30	BEVACQUA Tony	KOGLER Jim	HABU	4
19/06/71	980	03:09	PUGH Tom	RICE Ron	FERRY TO OL-RK	5.2
19/06/71	979	11:00	POWELL Bob	COLEMAN Gary	K9	2.3
21/06/71	978	10:00	BOWLES Ben	RICE Ron	K2	2.4
22/06/71	980		PUGH Tom	RICE Ron	K2	
23/06/71	978		BEVACQUA Tony	KOGLER Jim	HABU-BACKUP	
23/06/71	979	13:51	PUGH Tom	RICE Ron	HABU	3.5
24/06/71	980	10:00	BEVACQUA Tony	KOGLER Jim	K2	2.2
26/06/71	979	13:30	BOWLES Ben	FAGG Jimmy	HABU	5.7
27/06/71	978	13:00	PUGH Tom	RICH Ron	HABU	3.9
30/06/71	980	13:00	POWELL Bob	COLEMAN Gary	HABU	3.4
01/07/71	968	10:15	PUGH Tom	RICE Ron	K9	2.3
03/07/71	968	10:00	BEVACQUA Tony	KOGLER Jim	K9	2.3
04/07/71	980	11:00	POWELL Bob	COLEMAN Gary	HABU	3.7
05/07/71	978	13:00	BEVACQUA Tony	KOGLER Jim	HABU	5.3
08/07/71	968	10:00	BOWLES Ben	FAGG Jimmy	K9	2.4
10/07/71	979	10:19	BUSH Denny	LOIGNON Phil	K9	2.3
11/07/71	978	13:00	BOWLES Ben	FAGG Jimmy	HABU	5.5
13/07/71	978	12:00	PUGH Tom	RICE Ron	HABU	3.5
15/07/71	979	10:00	BEVACQUA Tony	KOGLER Jim	K7	2.3
17/07/71	979	11:30	BUSH Denny	LOIGNON Phil	HABU	1.5
17/07/71	978	12:30	BOWLES Ben	FAGG Jimmy	HABU	3.5
19/07/71	980	10:00	PUGH Tom	RICE Ron	K9	2.3
21/07/71	968		PUGH Tom	RICE Tom	HABU	
21/07/71	979	14:30	BUSH Denny	LOIGNON Phil	HABU	5.8
23/07/71	968	12:00	BOWLES Ben	FAGG Jimmy	HABU	3.4
24/07/71	979	10:00	SHELTON Jim	SCIMITTOU Tom	K9	1.8
27/07/71	979		PUGH Tom	RICE Ron	K9	
28/07/71	980		RUSH Denny	MARTINEZ Gil	K9	
28/07/71	979		PUGH Tom	RICE Ron	K9	
28/07/71	979	13:00	PUGH Tom	RICE Ron	K9	2.3
29/07/71	978	10:00	BUSH Denny	LOIGNON Phil	K9	1.5
30/07/71	979	11:30	BOWLES Ben	FAGG Jimmy	HABU	3.5
31/07/71	968	13:30	SHELTON Jim	SCHMITTOU Tom	K9	2.3
01/08/71	980	12:00	PUGH Tom	RICE Ron	K9	2.2
06/08/71	978		BUSH Denny	LOIGNON Phil	K7	
07/08/71	979	13:30	BUSH Denny	LOIGNON Phil	HABU	1.5
07/08/71	968	14:35	SHELTON Jim	SCHMITTOU Tom	HABU	3.6
08/08/71	978	10:10	SPENCER Bob	SHEFFIELD Butch	K9	2.2
08/08/71	979	13:55	BUSH Denny	LOIGNON Phil	RTB FERRY TO OL-KA	1.4
11/08/71	978	11:16	PUGH Tom	RICE Ron	K9	2.3
12/08/71	979	10:00	SHELTON Jim	SCHMITTOU Tom	K9	1.5
13/08/71	968	13:00	SPENCER Bob	SHEFFIELD Butch	HABU	1.4
13/08/71	978	14:00	BUSH Denny	LOIGNON Phil	HABU	3.5
14/08/71	979	10:00	SPENCER Bob	SHEFFIELD Butch	K9	2.3
15/08/71	968	12:15	SHELTON Jim	SCHMITTOU Tom	K9	2.2
18/08/71	978	09:07	PUGH Tom	RICE Ron	K9	1.4
19/08/71	968	09:00	BUSH Denny	LOIGNON Phil	K7	2.4
20/08/71	980	13:15	SPENCER Bob	SHEFFIELD Butch	K7	2.4
21/08/71	979	09:30	SHELTON Jim	SCHMITTOU Tom	HABU	3.5
23/08/71	980	10:15	CUNNINGHAM Bob	MORGAN George	K9	2.4
24/08/71	968	09:00	BUSH Denny	LOIGNON Phil	K7	1.6
26/08/71	978	09:45	SPENCER Bob	SHEFFIELD Butch	K9	1.6
27/08/71	978	10:00	SHELTON Jim	SCHMITTOU Tom	K7	2.3
30/08/71	978	12:30	SHELTON Jim	SCHMITTOU Tom	HABU	3.3
31/08/71	980	08:50	CUNNINGHAM Bob	MORGAN George	HABU	3.7
31/08/71	978	14:18	SHELTON Jim	SCHMITTOU Tom	RTB FERRY TO OL-KA	3.9
01/09/71	979	09:00	SPENCER Bob	SHEFFIELD Butch	K4	1.1
01/09/71	980	08:30	BUSH Denny	LOIGNON Phil	HABU	1.9
02/09/71	968	09:45	CUNNINGHAM Bob	MORGAN George	K9	2.5
03/09/71	979	11:30	SHELTON Jim	SCHMITTOU Tom	HABU	4.1
04/09/71	978	10:00	HERTZOG Randy	CARNOCHAN John	K7	1.5
09/09/71	968	08:24	SPENCER Bob	SHEFFIELD Butch	HABU	2.3
10/09/71	978	10:15	CUNNINGHAM Bob	MORGAN George	K7	0.5
11/09/71	968	11:30	SPENCER Bob	SHEFFIELD Butch	HABU	5.3
12/09/71	968	11:00	HERTZOG Randy	CARNOCHAN John	HABU	3.5
13/09/71	978	10:30	HERTZOG Randy	CARNOCHAN John	K9	2.3
15/09/71	979	10:00	CUNNINGHAM Bob	MORGAN George	HABU	4
16/09/71	978	10:00	SHELTON Jim	SCHMITTOU Tom	K9	2.1
17/09/71	968	11:30	HERTZOG Randy	CARNOCHAN John	HABU	5.8
18/09/71	980	10:38	COBB Darryl	BLACKWELL Reggie	K4	1.1
19/09/71	968	13:00	CUNNINGHAM Bob	MORGAN George	HABU	1.7
20/09/71	980	12:55	COBB Darryl	BLACKWELL Reggie	K9	2.3
20/09/71	979	11:30	SPENCER Bob	SHEFFIELD Butch	HABU	4.9
25/09/71	979	12:30	COBB Darryl	BLACKWELL Reggie	HABU	1.5
25/09/71	980	13:30	CUNNINGHAM Bob	MORGAN George	HABU	0.8
26/09/71	978	13:30	HERTZOG Randy	CARNOCHAN John	K9	1.6
27/09/71	979	11:32	COBB Darryl	BLACKWELL Reggie	K9	2.2
27/09/71	980	18:15	SPENCER Bob	SHEFFIELD Butch	N/HABU	2.6

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
28/09/71	978		CUNNINGHAM Bob	MORGAN George	K9	
28/09/71	980	19:43	SPENCER Bob	SHEFFIELD Butch	N/RTB FERRY	1.4
28/09/71	979	12:30	HERTZOG Randy	CARNOCHAN John	HABU	1.9
29/09/71	979	13:30	COBB Darryl	BLACKWELL Reggie	HABU	1.9
29/09/71	980	14:35	CUNNINGHAM Bob	MORGAN George	HABU	5.2
30/09/71	980		COBB Darryl	BLACKWELL Reggie	HABU	
30/09/71	978	10:05	HERTZOG Randy	CARNOCHAN John	K9	2.5
03/10/71	978	09:00	ESTES Tom	MORGAN George	K2	3.5
03/10/71	968	10:00	COBB Darryl	BLACKWELL Reggie	K9	2.3
04/10/71	980	11:00	HERTZOG Randy	CAHNOCHAN John	K7	2.3
05/10/71	978	12:00	CUNNINGHAM Bob	MORGAN George	HABU	3.4
07/10/71	980	12:30	CUNNINGHAM Bob	MORGAN George	HABU	3.4
07/10/71	968	13:55	ESTES Tom	VICK Dewain	K9	2.3
10/10/71	978	10:00	COBB Darryl	BLACKWELL Reggie	K9	2.4
12/10/71	968	10:40	CUNNINGHAM Bob	MORGAN George	HABU	3.6
14/10/71	980	09:55	ESTES Tom	VICK Dewain	HABU	2.2
14/10/71	978	14:00	HERTZOG Randy	CARNOCHAN John	HABU	3.6
16/10/71	978	10:00	FRUEHAUF Dave	MARTINEZ Gil	K9	2.3
16/10/71	979	11:00	COBB Darryl	BLACKWELL Reggie	K9	2.2
17/10/71	968	11:15	ESTES Tom	VICK Dewain	HABU	1.3
17/10/71	980	12:15	HERTZOG Randy	CARNOCHAN John	HABU	1.6
18/10/71	979	11:30	COBB Darryl	BLACKWELL Reggie	HABU	1.6
18/10/71	980	12:30	ESTES Tom	VICK Dewain	HABU	3.1
19/10/71	968	12:15	FRUEHAUF Dave	MARTINEZ Gil	HABU	3.6
20/10/71	979	09:00	HERTZOG Randy	CARNOCHAN John	K9	2.1
22/10/71	979	12:00	COBB Darryl	BLACKWELL Reggie	HABU	3.1
24/10/71	978	10:00	ESTES Tom	VICK Dewain	K9	1.8
25/10/71	978	12:00	FRUEHAUF Dave	MARTINEZ Gil	K9	1.7
27/10/71	980	08:50	HERTZOG Randy	CARNOCHAN John	HABU	2.3
31/10/71	979	12:00	POWELL Bob	COLEMAN Gary	HABU	1.8
01/11/71	980	10:00	ESTES Tom	VICK Dewain	K5	0.8
01/11/71	978	09:45	COBB Darryl	BLACKWELL Reggie	K9	2.3
02/11/71	978	11:00	COBB Darryl	BLACKWELL Reggie	HABU	1.2
03/11/71	979	11:00	FRUEHAUF Dave	MARTINEZ Gil	HABU	2.2
04/11/71	980	09:00	POWELL Bob	COLEMAN Gary	K5	1.6
06/11/71	980	10:00	ESTES Tom	VICK Dewain	K5	2.3
07/11/71	978	13:30	ESTES Tom	VICK Dewain	HABU	1.8
09/11/71	980	10:10	COBB Darryl	BLACKWELL Reggie	K5	2.4
10/11/71	979	12:00	FRUEHAUF Dave	MARTINEZ Gil	HABU	1.8
11/11/71	980	08:10	POWELL Bob	COLEMAN Gary	HABU	2.3
16/11/71	980	12:31	PUGH Tom	RICE Ron	K7	2.5
17/11/71	978	11:15	FRUEHAUF Dave	MARTINEZ Gil	HABU	3.6
18/11/71	980	11:30	ESTES Tom	VICK Dewain	HABU	1.4
18/11/71	968	12:45	POWELL Bob	COLEMAN Gary	K5	2.4
21/11/71	979	09:30	PUGH Tom	RICE Ron	K7	2.3
23/11/71	979	06:24	ESTES Tom	VICK Dewain	HABU	2.3
27/11/71	980	12:30	FRUEHAUF Dave	MARTINEZ Gil	HABU	1.9
27/11/71	968	13:45	POWELL Bob	COLEMAN Gary	K5	2.2
30/11/71	968	10:30	PUGH Tom	RICE Ron	K9	2.3
02/12/71	968	10:57	BULL George	KRAUS Jon	K5	2.3
05/12/71	979	11:15	FRUEHAUF Dave	MARTINEZ Gil	HABU	1.9
05/12/71	980	13:00	PUGH Tom	RICE Ron	K7	2.4
07/12/71	979	11:15	FRUEHAUF Dave	MARTINEZ Gil	HABU	1.3
09/12/71	980	11:30	POWELL Bob	COLEMAN Gary	K7	2.4
10/12/71	979	12:30	PUGH Tom	RICE Ron	HABU	1.8
10/12/71	968	13:45	BUSH Denny	KOGLER Jim	K5	2.4
12/12/71	979	11:45	POWELL Bob	COLEMAN Gary	HABU	3.4
13/12/71	978	10:00	PUGH Tom	RICE Ron	K7	2
13/12/71	968	13:52	BULL George	KRAUS Jon	HABU	2.4
15/12/71	968		BUSH Denny	KOGLER Jim	K7	
16/12/71	968	09:45	BUSH Denny	KOGLER Jim	K7	2.4
17/12/71	978	11:30	POWELL Bob	COLEMAN Gary	HABU	3.1
19/12/71	980	11:00	PUGH Tom	RICE Ron	HABU	3.5
20/12/71	978	10:00	BUSH Denny	KOGLER Jim	K9	2.3
20/12/71	968	13:15	BULL George	KRAUS Jon	HABU	2.4
21/12/71	968	12:15	BULL George	KRAUS Jon	HABU	5.1
21/12/71	980	13:30	BUSH Denny	KOGLER Jim	K9	2.3
23/12/71	980	09:45	PUGH Tom	RICE Ron	K9	1.8
28/12/71	978		BUSH Denny	KOGLER Jim	HABU	
28/12/71	980	13:00	BULL George	KRAUS Jon	HABU	1.9
28/12/71	979	09:00	SHELTON Jim	SCHMITTOU Tom	K3	3.5
31/12/71	979	10:00	BUSH Denny	KOGLER Jim	K3	2.3
02/01/72	978	11:00	BUSH Denny	KOGLER Jim	HABU	1.5
04/01/72	978	10:00	PUGH Tom	RICE Ron	K9	2.3
06/01/72	980	10:15	SHELTON Jim	SCHMITTOU Tom	K9	3.4
07/01/72	979	09:45	JUDKINS Ty	SHOEMAKER Clyde	K9	2.6
08/01/72	980	10:15	BULL George	KRAUS Jon	K3	2.3
12/01/72	980		JUDKINS Ty	SHOEMAKER Clyde	K5	
13/01/72	980	12:00	BUSH Denny	KOGLER Jim	HABU	4.2
14/01/72	978	10:00	SHELTON Jim	SCHMITTOU Tom	K9	2.4
16/01/72	980	12:30	SHELTON Jim	SCHMITTOU Tom	HABU	1.9
16/01/72	979	13:45	JUDKINS Ty	SHOEMAKER Clyde	K5	2.3
17/01/72	968	10:17	BULL George	KRAUS Jon	K9	2.3

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
18/01/72	978	10:15	BUSH Denny	KOGLER Jim	K7	2.5
20/01/72	978	12:47	BUSH Denny	KOGLER Jim	HABU	5.5
21/01/72	979	12:00	SHELTON Jim	SCHMITTOU Tom	HABU	5.1
22/01/72	968	12:30	JUDKINS Ty	SHOEMAKER Clyde	HABU	1.6
22/01/72	978	13:45	BOWLES Ben	FAGG Jimmy	K7	2.6
24/01/72	968	12:45	SHELTON Jim	SCHMITTOU Tom	K9	2.4
24/01/72	979	11:40	JUDKINS Ty	SHOEMAKER Clyde	HABU	5.4
27/01/72	968		SHELTON Jim	SCHMITTOU Tom	K9	
27/01/72	979	13:45	BOWLES Ben	FAGG Jimmy	HABU	2.1
28/01/72	968		BUSH Denny	KOGLER Jim	K5	
28/01/72	978	11:30	SHELTON Jim	SCHMITTOU Tom	HABU	1.9
30/01/72	968	10:00	BUSH,Denny	KOGLER Jim	K9	2.3
01/02/72	978	13:00	BUSH Denny	KOGLER Jim	HABU	5.5
02/02/72	968	11:15	SHELTON Jim	SCHMITTOU Tom	K7	2.3
02/02/72	979	10:00	JUDKINS Ty	SHOEMAKER Clyde	HABU	3.6
04/02/72	968	12:00	SHELTON Jim	SCHMITTOU Tom	K5	2.4
05/02/72	979	12:15	BOWLES Ben	FAGG Jimmy	HABU	3.6
08/02/72	978	10:15	CUNNINGHAM Bob	MORGAN George	K4	1
10/02/72	979	10:35	JUDKINS Ty	SHOEMAKER Clyde	HABU	1.4
11/02/72	968	13:15	CUNNINGHAM Bob	MORGAN George	HABU	2.1
11/02/72	978	14:15	SHELTON Jim	SCHMITTOU Tom	HABU	3.8
14/02/72	979		11:15	BOWLES Ben	FAGG Jimmy	HABU
15/02/72	980	10:15	CUNNINGHAM Bob	MORGAN George	K9	1.7
16/02/72	968	11:15	JUDKINS Ty	SHOEMAKER Clyde	K9	2.3
17/02/72	980	10:00	BOWLES Ben	FAGG Jimmy	K9	2.2
18/02/72	968	09:45	HERTZOG Randy	FAGG Jimmy	HABU	2.2
19/02/72	979	13:00	BOWLES Ben	FAGG Jimmy	HABU	5.5
24/02/72	979	10:30	JUDKINS Ty	SHOEMAKER Clyde	K9	2.3
25/02/72	980	13:00	JUDKINS Ty	SHOEMAKER Clyde	HABU	5.4
29/02/72	968	13:00	CUNNINGHAM Bob	MORGAN George	K9	2.3
02/03/72	979	10:15	HERTZOG Randy	CARNOCHAN John	K9	2.3
03/03/72	980	10:00	SULLIVAN Jim	WIDDIFIELD Noel	K9	2.3
03/03/72	968	11:15	BOWLES Ben	FAGG Jimmy	K9	2.3
04/03/72	979	13:00	BOWLES Ben	FAGG Jimmy	HABU	4.1
05/03/72	979	10:10	CUNNINGHAM Bob	MORGAN George	HABU	3.5
05/03/72	979	17:10	BOWLES Ben	FAGG Jimmy	RTB FERRY	3.7
06/03/72	980	13:15	CUNNINGHAM Bob	MORGAN George	HABU	5.3
08/03/72	979	10:30	HERTZOG Randy	CARNOCHAN John	K9	2.3
09/03/72	980	08:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	2.3
11/03/72	968	10:00	BOWLES Ben	FAGG Jimmy	K9	2.3
12/03/72	980	10:30	HERTZOG Randy	CARNOCHAN John	K9	2.2
15/03/72	979	13:15	HERTZOG Randy	CARNOCHAN John	HABU	4
16/03/72	980	10:15	CUNNINGHAM Bob	MORGAN George	K9	2.3
17/03/72	978	11:15	SPENCER Bob	SHEFFIELD Butch	K9	2.4
17/03/72	968	12:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	1.5
18/03/72	968	09:45	SULLIVAN Jim	WIDDIFIELD Noel	RTB FERRY	1.3
20/03/72	980	12:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.1
22/03/72	968	09:15	HERTZOG Randy	CARNOCHAN John	K9	2.2
22/03/72	979	10:30	CUNNINGHAM Bob	MORGAN George	K9	1.5
23/03/72	978	14:00	SPENCER Bob	SHEFFIELD Butch	HABU	4.1
26/03/72	980	10:00	HERTZOG Randy	CARNOCHAN John	K9	2.3
26/03/72	978	14:00	CUNNINGHAM Bob	MORGAN George	HABU	1.8
29/03/72	979	10:25	SULLIVAN Jim	WIDDIFIELD Noel	K9	2.3
29/03/72	978	07:14	SPENCER Bob	SHEFFIELD Butch	HABU	2.3
30/03/72	980	10:00	SULLIVAN Jim	WIDDIFIELD Noel	K9	1.5
31/03/72	980	15:16	COBB Darryl	BLACKWELL Reggie	K4	1.2
01/04/72	979	08:30	HERTZOG Randy	CARNOCHAN John	HABU	1.9
02/04/72	968	10:15	SPENCER Bob	SHEFFIELD Butch	K9	2.4
03/04/72	979		SULLIVAN Jim	WIDDIFIELD Noel	HABU	
04/04/72	980	09:15	COBB Darryl	BLACKWELL Reggie	K7	2.4
04/04/72	968	13:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.6
05/04/72	980	14:00	HERTZOG Randy	CARNOCHAN John	HABU	3.8
07/04/72	979	11:05	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4
08/04/72	980	10:00	COBB Darryl	BLACKWELL Reggie	K4	1.1
09/04/72	968	11:30	HERTZOG Randy	CARNOCHAN John	HABU	1.9
11/04/72	968	13:30	SPENCER Bob	SHEFFIELD Butch	HABU	3.7
12/04/72	968	12:15	COBB Darryl	BLACKWELL Reggie	HABU	3.9
13/04/72	978	14:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.9
14/04/72	978	14:00	FRUEHAUF Dave	MARTINEZ Gil	HABU	4.1
16/04/72	980	14:55	SPENCER Bob	SHEFFIELD Butch	HABU	3.8
17/04/72	978	13:00	COBB Darryl	BLACKWELL Reggie	HABU	4.1
17/04/72	968	14:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.1
18/04/72	980	09:00	SPENCER Bob	SHEFFIELD Butch		K9
18/04/72	979	10:00	SULLIVAN Jim	WIDDIFIELD Noel	K9	2
19/04/72	968	09:00	FRUEHAUF Dave	MARTINEZ Gil	K9	2.3
19/04/72	980	10:00	COBB Darryl	BLACKWELL Reggie	K9	2.3
20/04/72	978		FRUEHAUF Dave	MARTINEZ Gil	HABU	
20/04/72	980	13:00	SPENCER Bob	SHEFFIELD Butch	HABU	4.2
23/04/72	979	14:30	FRUEHAUF Dave	MARTINEZ Gil	HABU	4.1
25/04/72	979	10:00	SULLIVAN Jim	WIDDIFIELD Noel	K9	2.3
26/04/72	978	10:00	COBB Darryl	BLACKWELL Reggie	HABU	3.9
27/04/72	980	14:30	SPENCER Bob	SHEFFIELD Butch	HABU	4.1
29/04/72	979	12:09	PUGH Tom	RICE Ron	HABU	2.4

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
30/04/72	980	11:00	COBB Darryl	BLACKWELL Reggie	K9	2.3
30/04/72	968	14:54	FRUEHAUF Dave	MARTINEZ GIL	K9	2.3
01/05/72	979	10:30	PUGH Tom	RICE Ron	RTD FERRY	2.1
02/05/72	980	14:18	COBB Darryl	BLACKWELL Reggie	HABU	3.8
02/05/72	979	14:16	SPENCER Bob	SHEFFIELD Butch	BABU	4.8
02/05/72	968	15:22	FRUEHAUF Dave	MARTINEZ Gil	HABU	4.1
03/05/72	978	13:00	PUGH Tom	RICE Ron	K9	2.3
04/05/72	980	14:16	SPENCER Bob	SHEFFIELD Butch	BABU	3.9
04/05/72	978	14:18	COBB Darryl	BLACKWELL Reggie	HABU	4.1
04/05/72	968	15:22	PUCH Tom	RICE Ron	HABU	4.2
08/05/72	978		FRUEHAUF Dave	MARTINEZ Gil	HABU	
08/05/72	978	15:05	COBB Darryl	BLACKWELL Reggie	HABU	4.1
09/05/72	980	12:00	SPENCER Bob	SHEFFIELD Butch	HABU	4.2
10/05/72	980	14:03	FRUEHAUF Dave	MARTINEZ Gil	HABU	4.2
10/05/72	979	15:50	PUGH Tom	RICE Ron	K9	1.8
11/05/72	978	12:00	PUGH Tom	RICE Ron	HABU	4.4
12/05/72	979	13:00	ESTES Tom	VICK Dewain	HABU	4.2
13/05/72	968		ESTES Tom	VICK Dewain	K9	
13/05/72	978	13:00	COBB Darryl	BLACKWELL Reggie	HABU	4.2
14/05/72	968	09:30	ESTES Tom	VICK Dewain	K9	1.7
14/05/72	979	12:50	FRUEHAUF Dave	MARTINEZ Gil	HABU	4
15/05/72	978	11:45	PUGH Tom	RICE Ron	HABU	1.6
16/05/72	979	14:15	COBB Darryl	BLACKWELL Reggie	K9	1.6
16/05/72	968	13:00	ESTES Tom	VICK Dewain	HABU	4.1
17/05/72	979	13:00	COBB Darryl	BLACKWELL Reggie	HABU	2.3
17/05/72	978	14:00	PUGH Tom	RICE Ron	RTB FERRY	3.6
17/05/72	968	14:14	FRUEHAUF Dave	MARTINEZ Gil	HABU	2.5
18/05	968	11:52	FRUEHAUF Dave	MARTINEZ Gil	RTB FERRY	2.6
18/05/72	978	12:42	PUGH Tom	RICE Ron	K9	2.3
18/05/72	978	11:40	COBB Darryl	BLACKWELL Reggie	HABU	4
19/05/72	978	11:50	PUGH Tom	RICE Ron	HABU	4.1
20/05/72	979	12:15	ESTES Tom	VICK Dewain	HABU	4.1
21/05/72	978	12:00	FRUEHAUF Dave	MARTINEZ Gil	HABU	4.1
22/05/72	968	11:50	COBB Darryl	BLACKWELL Reggie	HABU	4.2
23/05/72	980		COBB Darryl	BLACKWELL Reggie	K9	
23/05/72	979	12:20	PUGH Tom	RICE Ron	HABU	4.1
24/05/72	980	09:30	COBB Darryl	BLACKWELL Reggie	K9	2.3
24/05/72	978	12:50	ESTES Tom	VICK Dewain	HABU	3.8
25/05/72	968	14:30	FRUEHAUF Dave	MARTINEZ Gil	HABU	4
26/05/72	980	16:05	PUGH Tom	RICE Ron	K9	2.3
26/05/72	979	14:50	POWELL Bob	COLEMAN Gary	HABU	4.1
27/05/72	968	12:30	PUGH Tom	RICE Ron	HABU	4.1
28/05/72	980	14:45	FRUEHAUF Dave	MARTINEZ Gil	HABU	1.9
28/05/72	978	13:00	ESTES Tom	VICK Dewain	HABU	4.2
29/05/72	968	14:00	FRUEHAUF Dave	MARTINEZ Gil	HABU	4.1
30/05/72	978	13:30	POWELL Bob	COLEMAN Gary	HABU	4.2
31/05/72	980	14:15	PUGH Tom	RICE Ron	HABU	4.2
01/06/72	968	12:00	FRUEHAUF Dave	MARTINEZ Gil	HABU	4.2
02/06/72	978	13:00	ESTES Tom	VICK Dewain	HABU	3.8
03/06/72	979	12:00	POWELL Bob	COLEMAN Gary	HABU	4.1
04/06/72	968	11:30	PUGH Tom	RICE Ron	HABU	2.3
05/06/72	979	13:30	FRUEHAUF Dave	MARTINEZ Gil	HABU	4.3
06/06/72	980	13:05	ESTES Tom	VICK Dewain	HABU	4.2
07/06/72	978	13:30	POWELL Bob	COLEMAN Gary	HABU	4.4
08/06/72	979	13:40	PUGH Tom	RICE Ron	HABU	2
08/06/72	980	15:20	ESTES Tom	VICK Dewain	HABU	4
09/06/72	968	09:00	GUNTHER Bud	ALLOCCA Tom	K7	2.4
09/06/72	978	10:45	POWELL Bob	COLEMAN Gary	HABU	6.3
10/06/72	979	12:00	PUGH Tom	RICE Ron	HABU	4.2
11/06/72	980	14:00	GUNTHER Bud	ALLOCCA Tom	HABU	4.2
12/06/72	979	13:00	ESTES Tom	VICK Dewain	HABU	4.1
13/06/72	978	13:30	POWELL Bob	COLUMAN Gary	HABU	4.5
14/06/72	980	12:00	PUGH Tom	RICE Ron	HABU	4.2
15/06/72	968	10:30	GUNTHER Bud	ALLOCCA Tom	HABU	4.1
16/06/72	978	10:00	ESTES Tom	VICK Dewain	HABU	4.2
17/06/72	980	11:00	POWELL Bob	COLEMAN Gary	HABU	4.1
18/06/72	978		PUGH Tom	RICE Ron	HABU	
19/06/72	968	13:30	PUGH Tom	RICE Ron	HABU	4.1
20/06/72	978		GUNTHER Bud	ALIOCCA Tom	HABU	
20/06/72	980	13:30	ESTES Tom	VICK Dewain	HABU	3.9
21/06/72	978	14:15	GUNTHER Bud	ALLOCCA Tom	HABU	4.1
22/06/72	979	13:00	POWELL Bob	COLEMAN Gary	HABU	4
23/06/72	979	13:30	ESTES Tom	VICK Dewain	HABU	4.1
24/06/72	980	13:00	BUSH Denny	FAGG Jimmy	HABU	4
25/06/72	968	12:30	GUNTHER Bud	ALLOCCA Tom	HABU	4.2
26/06/72	978	13:30	POWELL Bob	COLEMAN Gary	HABU	4
27/06/72	979	13:00	ESTES Tom	VICK Dewain	HABU	3.8
29/06/72	968	12:00	BUSH Denny	FAGG Jimmy	HABU	4.1
30/06/72	980	11:00	GUNTHER Bud	ALLOCCA Tom	HABU	4.3
01/07/72	978	12:30	POWELL Bob	COLEMAN Gary	HABU	1.9
01/07/72	979	14:10	ESTES Tom	VICK Dewain	HABU	3.8
02/07/72	978	12:25	POWELL Bob	COLEMAN Gary	RTB FERRY	2.2
02/07/72	968	13:30	BUSH Denny	FAGG Jimmy	HABU	4.2

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
03/07/72	980	12:15	GUNTHER Bud	ALLOCCA Tom	HABU	6.3
04/07/72	978	13:40	ESTES Tom	VICK Dewain	HABU	4
05/07/72	979	13:00	POWELL Bob	COLEMAN Gary	HABU	2.1
05/07/72	968	14:30	BUSH Denny	FAGG Jimmy	HABU	4
06/07/72	968	12:30	GUNTHER Bud	ALLOCCA Tom	HABU	4.1
07/07/72	979	13:00	POWELL Bob	COLEMAN Gary	HABU	1.9
07/07/72	980	14:30	BUSH Denny	FAGG Jimmy	HABU	4.1
08/07/72	968	13:00	JUDKINS Ty	KRAUS Jon	HABU	4.3
09/07/72	980	09:15	GUNTHER Bud	ALLOCCA Tom	HABU	4.1
10/07/72	968	11:30	POWELL Bob	COLEMAN Gary	HABU	4.3
11/07/72	979		GUNTHER Bud	ALLOCCA Tom	K9	
11/07/72	968	11:00	BUSH Denny	FAGG Jimmy	HABU	1
13/07/72	979		GUNTHER Bud	ALLOCCA Tom	K9	
13/07/72	978	09:30	JUDKINS Ty	KRAUS Jon	K7	2.4
13/07/72	979	12:38	GUNTHER Bud	ALLOCCA Tom	K9	1.9
14/07/72	968	12:00	JUDKINS Ty	KRAUS Jon	HABU	4.2
14/07/72	979	14:00	POWELL Bob	COLEMAN Gary	K9	2.1
15/07/72	978	11:30	GUNTHER Bud	ALLOCCA Tom	HABU	4.2
16/07/72	978	08:34	GUNTHER Bud	ALLOCCA Tom	RTB FERRY TO OL-KA	1.2
16/07/72	980	09:10	POWELL Bob	COLHMAN Gary	HABU	1.9
16/07/72	979	10:40	JUDKINS Ty	KRAUS Jon	HABU	1.5
17/07/72	979	10:00	POWELL Bob	COLEMAN Gary	HABU	4.1
18/07/72	978	11:00	GUNTHER Bud	ALLOCCA Tom	HABU	4.1
18/07/72	980	11:00	POWELL Bob	COLEMAN Gary	K9	2.2
19/07/72	979	11:00	JUDKINS Ty	KRAUS Jon	HABU	4.1
20/07/72	978	12:20	BUSH Denny	FAGG Jimmy	HABU	4
27/07/72	980	11:15	CUNNINGHAM Bob	MORGAN George	HABU	1.7
27/07/72	979	12:45	GUNTHER Bud	ALLOCCA Tom	HABU	1.2
28/07/72	968		JUDKINS Ty	KRAUS Jon	K9	
28/07/72	979	10:30	CUNNINGHAM Bob	MORGAN George	HABU	4
29/07/72	968		CUNNINGHAM Bob	MORGAN George	K9	
29/07/72	979	13:00	GUNTHER Bud	ALLOCCA Tom	HABU	4
30/07/72	979	13:15	CUNNINGHAM Bob	MORGAN George	HABU	3.9
30/07/72	968	16:00	GUNTHER Bud	ALLOCCA Tom	K9	2.2
31/07/72	968		JUDKINS Ty	KRAUS Jon	HABU	
31/07/72	979	13:45	GUNTHER Bud	ALLOCCA Tom	HABU	4.5
01/08/72	979		CUNNINGHAM Bob	MORGAN George	HABU	
01/08/72	968	12:30	JUDKINS Ty	KRAUS Jon	HABU	0.6
02/08/72	968	13:20	CUNNINGHAM Bob	MORGAN George	K9	2.2
02/08/72	968	11:30	JUDKINS Ty	KRAUS Jon	HABU	4.2
03/08/72	968	11:00	CUNNINGHAM Bob	MORGAN George	HABU	4.2
03/08/72	980	12:50	GUNTHDR Bud	ALLOCCA Tom	K9	2.4
04/08/72	968	12:34	GUNTHER Bud	ALLOCCA Tom	HABU	4.5
05/08/72	980	11:30	JUDKINS Ty	KRAUS Jon	HABU	4
06/08/72	968	12:30	CUNNINGHAM Bob	MORGAN George	HABU	4.1
06/08/72	979	14:20	GUNTHER Bud	ALLOCCA Tom	K7	2.3
07/08/72	979	12:00	GUNTHER Bud	ALLOCCA Tom	HABU	4.4
08/08/72	968		JUDKINS Ty	KRAUS Jon	HABU	
09/08/72	979	14:00	JUDKINS Ty	KRAUS Jon	HABU	4
09/08/72	979	11:00	CUNNINGHAM Bob	MORGAN George	HABU	4.1
10/08/72	968	2	JUDKINS Ty	KRAUS Jon	HABU	4
11/08/72	975	11:00	POWELL Bob	COLEMAN Gary	FERRY TO OL-KA	5.4
11/08/72	979	?	CUNNINGHAM Bob	MORGAN George	HABU	3.3
12/08/72	980		GUNTHER Bud	ALLOCCA Tom	FERRY OUT BACKUP	
12/08/72	979	06:30	JUDKINS Ty	KRAUS Jon	FERRY OUT	
12/08/72	968	15:30	POWELL Bob	COLEMAN Gary	HABU	0.7
12/08/72	975	15:45	CUNNINGHAM Bob	MORGAN George	HABU	4.1
13/08/72	975	12:30	GUNTHER Bud	ALLOCCA Tom	HABU	4.1
14/08/72	968	11:30	POWELL Bob	COLEMAN Gary	HABU	4.1
14/08/72	971	03:00	SULLIVAN Jim	WIDDIFIELD Noel	FERRY TO OL-KA	5.3
15/08/72	980	06:00	GUNTHER Bud	ALLOCCA Tom	FERRY OUT	
15/08/72	971	13:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.1
18/08/72	961	03:00	SHELTON Jim	SCHMITTOU Tom	FERRY TO OL-KA	5.3
18/08/72	975	12:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.2
19/08/72	968	06:00	POWELL Bob	COLEMAN Gary	FERRY OUT	
19/08/72	961	12:10	CUNNINGHAM Bob	MORGAN George	HABU	4.2
20/08/72	975	12:15	SHELTON Jim	SCHMITTOU Tom	HABU	4.3
21/08/72	963	03:00	COBB Darryl	BLACKWELL Reggie	FERRY TO OL-KA	5.1
21/08/72	961	11:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4
22/08/72	971	13:00	COBB Darryl	BLACKWELL Reggie	HABU	4.1
23/08/72	963	12:00	CUNNINGHAM Bob	MORGAN George	HABU	4.3
23/08/72	961	14:45	SHELTON Jim	SCHMITTOU Tom	K5	2.3
24/08/72	975	10:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	1.6
24/08/72	971	12:00	SHELTON Jim	SCHMITTOU Tom	HABU	4.3
25/08/72	961		SHELTON Jim	SCHMITTOU Tom	K5	
25/08/72	963	12:15	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.3
26/08/72	975	11:00	COBB Darryl	BLACKWELL Reggie	HABU	3.5
27/08/72	975	13:15	COBB Darryl	BLACKWELL Reggie	RTB FERRY	2.4
27/08/72	971	12:00	CUNNINGHAM Bob	MORGAN George	HABU	4.1
28/08/72	963	11:30	SHELTON Jim	SCHMITTOU Tom	HABU	4.3
29/08/72	961	11:20	CUNNINGHAM Bob	MORGAN George	K4	0.7

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
29/08/72	971	09:10	SULLIVAN Jim	WIDDIFIELD Noel	HABU	1.9
29/08/72	963	12:10	COBB Darryl	BLACKWELL Reggie	HABU	2.3
31/08/72	971		CUNNINGHAM Bob	MORGAN George	HABU	
31/08/72	963	12:44	CUNNINGHAM Bob	MORGAN George	HABU	3.9
01/09/72	971	14:15	SHELTON Jim	SCHMITTOU Tom	HABU	4
02/09/72	975		SHELTON Jim	SCHMITTOU Tom	K4	
02/09/72	961		SULLIVAN Jim	WIDDIFIELD Noel	HABU	
02/09/72	963	11:30	COBB Darryl	BLACKWELL Reggie	HABU	1.1
03/09/72	961	08:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	2.5
04/09/72	961	16:15	SULLIVAN Jim	WIDDIFIELD Noel	RTB FERRY	2
04/09/72	971	09:30	CUNNINGHAM Bob	MORGAN George	HABU	4.1
05/09/72	971	11:30	SHELTON Jim	SCHMITTOU Tom	HABU	4.1
06/09/72	961	13:00	COBB Darryl	BLACKWELL Reggie	HABU	1.6
06/09/72	975	14:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.2
07/09/72	961	12:00	COBB Darryl	BLACKWELL Reggie	HABU	4.3
08/09/72	975	13:45	SHELTON Jim	SCHMITTOU Tom	HABU	4.3
09/09/72	975		SULLIVAN Jim	WIDDIFIELD Noel	HABU	
09/09/72	971	15:15	COBB Darryl	BLACKWELL Reggie	HABU	4.1
10/09/72	975	11:45	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4
11/09/72	975	13:30	SHELTON Jim	SCHMITTOU Tom	HABU	4.1
12/09/72	961	12:00	COBB Darryl	BLACKWELL Reggie	HABU	4.1
12/09/72	963	14:17	HALLER Carl	FULLER John	K9	2.2
13/09/72	961	08:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	1.7
13/09/72	971	10:00	HALLER Carl	FULLER John	HABU	4.4
14/09/72	963	09:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4
15/09/72	961	08:30	COBB Darryl	BLACKWELL Reggie	HABU	1.7
15/09/72	963	10:00	SHELTON Jim	SCHMITTOU Tom	HABU	4
15/09/72	971	11:00	HALLER Carl	FULLER John	HABU	3.6
17/09/72	963	11:30	COBB Darryl	BLACKWELL Reggie	HABU	4.1
18/09/72	963	12:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.2
18/09/72	975	14:03	COBB Darryl	BLACKWELL Reggie	HABU	3.4
19/09/72	975	13:00	HALLER Carl	FULLER John	HABU	4
20/09/72	975	08:00	SHELTON Jim	SCHMITTOU Tom	HABU	4.2
21/09/72	971	09:30	COBB Darryl	BLACKWELL Reggie	HABU	3.8
22/09/72	975	11:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.1
22/09/72	961	12:50	COBB Darryl	BLACKWELL Reggie	K9	2.3
23/09/72	963	12:00	HALLER Carl	FULLER John	HABU	4.3
23/09/72	971	12:45	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.6
24/09/72	961	13:00	SHELTON Jim	SCHMITTOU Tom	HABU	4.1
25/09/72	963	13:15	COBB Darryl	BLACKWELL Reggie	HABU	1.8
25/09/72	971	14:45	SULLIVAN Jim	WIDDIFIELD Noel	HABU	2.3
26/09/72	961	10:30	COBB Darryl	BLACKWELL Reggie	HABU	4.1
27/09/72	963	12:00	HALLER Carl	FULLER John	HABU	2.2
27/09/72	963	13:30	SHELTON Jim	SCHMITTOU Tom	HABU	4
28/09/72	963	10:00	HALLER Carl	FULLER John	HABU	4.3
28/09/72	971	11:50	COBB Darryl	BLACKWELL Reggie	K4	1.1
29/09/72	971	12:00	POWELL Bob	COLEMAN Gary	HABU	3.9
30/09/72	971	11:30	COBB Darryl	BLACKWELL Reggie	HABU	4.1
30/09/72	961	14:00	POWELL Bob	COLEMAN Gary	HABU	3.4
01/10/72	961	12:10	SHELTON Jim	SCHMITTOU Tom	HABU	4.1
02/10/72	961	09:45	HALLER Carl	FULLER John	HABU	4
03/10/72	963	09:15	POWELL Bob	COLEMAN Gary	HABU	3.9
04/10/72	975		POWELL Bob	COLEMAN Gary	K9	
04/10/72	961	10:00	COBB Darryl	BLACKWELL Reggie	HABU	4
05/10/72	975	10:00	COBB Darryl	BLACKWELL Reggie	K9	1.8
05/10/72	971	13:00	SHELTON Jim	SCHMITTOU Tom	HABU	4.1
06/10/72	963	12:15	HALLER Carl	FULLER John	HABU	4.1
07/10/72	971	09:30	POWELL Bob	COLEMAN Gary	HABU	4.1
07/10/72	975	11:20	HALLER Carl	FULLER John	K9	2.2
08/10/72	975	12:00	COBB Darryl	BLACKWELL Reggie	HABU	4.1
09/10/72	971	12:30	SHELTON Jim	SCHMITTOU Tom	HABU	4.2
10/10/72	963	12:15	HALLER Carl	FULLER John	HABU	6.9
10/10/72	975	13:50	POWELL Bob	COLEMAN Gary	K4	0.9
11/10/72	971	10:00	POWELL Bob	COLEMAN Gary	HABU	3.4
12/10/72	963	11:30	COBB Darryl	BLACKWELL Reggie	HABU	1
12/10/72	971	13:00	HALLER Carl	FULLER John	HABU	4
13/10/72	963	12:30	COBB Darryl	BLACKWELL Reggie	HABU	2.2
13/10/72	975	14:20	HERTZOG Randy	RICE Ron	K4	1
14/10/72	971	13:00	COBB Darryl	BLACKWELL Reggie	HABU	4.1
14/10/72	961	14:58	POWELL Bob	COLEMAN Gary	K9	2.2
15/10/72	975	08:45	HERTZOG Randy	RICE Ron	HABU	3.9
16/10/72	975	11:00	POWELL Bob	COLEMAN Gary	HABU	3.9
16/10/72	961	14:15	HERTZOG Randy	RICE Ron	HABU	1.7
17/10/72	963	12:30	HALLER Carl	FULLER John	HABU	4.2
18/10/72	961	12:04	COBB Darryl	BLACKWELL Reggie	HABU	4.2
20/10/72	975	12:20	HERTZOG Randy	RICE Ron	HABU	4
21/10/72	961	10:00	POWELL Bob	COLEMAN Gary	HABU	3.5
24/10/72	963	11:45	HALLER Carl	FULLER John	HABU	4.2
25/10/72	975	10:00	COBB Darryl	BLACKWELL Reggie	K5	2.3
26/10/72	961	14:13	HERTZOG Randy	RICE Ron	HABU	1.7
28/10/72	975	12:00	POWELL Bob	COLEMAN Gary	HABU	3.8
29/10/72	971	10:00	BLEDSOE Pat	CARNOCHAN John	K9	2.3
30/10/72	961	12:45	BLEDSOE Pat	CARNOCHAN John	HABU	4

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
31/10/72	963	12:15	HALLER Carl	FULLER John	HABU	3.5
02/11/72	975		HALLER Carl	FULLER John	HABU	
02/11/72	963	11:33	HERTZOG Randy	RICE Ron	HABU	4.1
02/11/72	975	13:18	POWELL Bob	COLEMAN Gary	HABU	0.3
03/11/72	971	12:44	HALLER Carl	FULLER John	HABU	4.3
04/11/72	971	13:30	POWELL Bob	COLEMAN Gary	HABU	4.9
07/11/72	975	10:00	BLEDSOE Pat	CARNOCHAN John	HABU	1.4
09/11/72	961	10:00	HERTZOG Randy	RICE Ron	K9	2.3
10/11/72	971	11:00	BLEDSOE Pat	CARNOCHAN John	HABU	4.1
11/11/72	971	13:45	POWELL Bob	COLEMAN Gary	HABU	1.8
12/11/72	975	12:00	JUDKINS Ty	MORGAN George	HABU	4.1
14/11/72	963	13:00	HERTZOG Randy	RICE Ron	HABU	4.2
15/11/72	963	11:00	BLEDSOE Pat	CARNOCHAN John	HABU	4
18/11/72	961		JUDKINS Ty	MORGAN George	HABU	
18/11/72	961	13:15	JUDKINS Ty	MORGAN George	HABU	3.5
19/11/72	975	12:30	HERTZOG Randy	RICE Ron	HABU	1.6
19/11/72	961	14:00	JUDKINS Ty	MORGAN George	HABU	4.2
21/11/72	975	10:00	BLEDSOE Pat	CARNOCHAN John	K9	2.4
21/11/72	961	11:00	GUNTHER Bud	ALLOCCA Tom	HABU	3.6
25/11/72	971	10:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	1.9
28/11/72	961	10:20	BLEDSOE Pat	CARNOCHAN John	K9	2.4
01/12/72	975	08:30	BLEDSOE Pat	CARNOCHAN John	HABU	2.2
02/12/72	971	12:00	GUNTHER Bud	ALLOCCA Tom	HABU	4.1
02/12/72	975	12:50	BLEDSOE Pat	CARNOCHAN John	RTB FERRY	3.8
04/12/72	963		RANSOM Lee	GERSTEN Mark	K9	
04/12/72	961	11:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.1
05/12/72	971	10:00	JUDKINS Ty	MORGAN George	HABU	4
05/12/72	963	12:12	RANSOM Lee	GERSTEN Mark	K9	2.4
06/12/72	971	12:00	RANSOM Lee	GERSTEN Mark	HABU	4
08/12/72	963	12:30	GUNTHER Bud	ALLOCCA Tom	HABU	4
11/12/72	975	10:00	RANSOM Lee	GERSTEN Mark	K9	2.2
11/12/72	961	11:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4
12/12/72	975	13:30	RANSOM Lee	GERSTEN Mark	HABU	3.7
15/12/72	975	10:00	COBB Darryl	BLACKWELL Reggie	HABU	4.2
15/12/72	963	13:00	RANSOM Lee	GERSTEN Mark	HABU	3.5
19/12/72	975		SULLIVAN Jim	WIDDIFIELD Noel	HABU	
19/12/72	961	14:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.1
20/12/72	961	12:00	COBB Darryl	BLACKWELL Reggie	HABU	4.2
21/12/72	975	11:45	RANSOM Lee	GERSTEN Mark	HABU	4.1
22/12/72	963	12:10	COBB Darryl	BLACKWELL Reggie	HABU	4
23/12/72	975	12:30	CUNNINGHAM Bob	FAGG Jimmy	HABU	4.9
23/12/72	961	14:12	RANSOM Lee	GERSTEN Mark	HABU	4.3
24/12/72	971	13:00	COBB Darryl	BLACKWELL Reggie	HABU	4.1
25/12/72	975	13:00	CUNNINGHAM Bob	FAGG Jimmy	HABU	4
27/12/72	963		RANSOM Lee	GERSTEN Mark	HABU	
27/12/72	963	14:20	RANSOM Lee	GERSTEN Mark	HABU	3.8
28/12/72	975	22:45	COBB Darryl	BLACKWELL Reggie	N-HABU	3.9
29/12/72	971	13:00	CUNNINGHAM Bob	FAGG Jimmy	HABU	4.1
01/01/73	975		RANSOM Lee	GERSTEN Mark	HABU	
01/01/73	963		COBB Darryl	BLACKWELL Reggie	HABU	
02/01/73	975	10:00	RANSOM Lee	GERSTEN Mark	HABU	5.9
03/01/73	963	12:39	COBB Darryl	BLACKWELL Reggie	HABU	4.3
04/01/73	961	12:40	CUNNINGHAM Bob	FAGG Jimmy	HABU	3.4
07/01/73	971	11:46	BLEDSOE Pat	CARNOCHAN John	HABU	4.4
08/01/73	963	10:00	COBB Darryl	BLACKWELL Reggie	HABU	4.3
10/01/73	961	12:00	BLEDSOE Pat	CARNOCHAN John	HABU	3.5
13/01/73	963	12:00	CUNNINGHAM Bob	FAGG Jimmy	HABU	4
14/01/73	971	14:00	SHELTON Jim	SCHMITTOU Tom	HABU	4.2
15/01/73	961	12:00	BLEDSOE Pat	CARNOCHAN John	HABU	3.9
16/01/73	963	12:05	SHELTON Jim	SCHMITTOU Tom	HABU	2.3
19/01/73	963	12:00	CUNNINGHAM Bob	FAGG Jimmy	K9	2.3
20/01/73	961	12:45	CUNNINGHAM Bob	FAGG Jimmy	HABU	4
20/01/73	975	15:15	SHELTON Jim	SCHMITTOU Tom	K9	2
21/01/73	961	12:00	SHELTON Jim	SCHMITTOU Tom	HABU	4.1
22/01/73	971	12:00	BLEDSOE Pat	CARNOCHAN John	HABU	4.1
23/01/73	975	12:00	CUNNINGHAM Bob	FAGG Jimmy	HABU	4.3
24/01/73	971	12:50	SHELTON Jim	SCHMITTOU Tom	HABU	4.3
25/01/73	963	12:30	BLEDSOE Pat	CARNOCHAN John	HABU	1.9
26/01/73	975	11:45	SHELTON Jim	SCHMITTOU Tom	K9	2.2
30/01/73	971	10:00	JUDKINS Ty	MORGAN George	K10	2.2
31/01/73	963	12:45	JUDKINS Ty	MORGAN George	HABU	3.5
01/02/73	971	11:00	SHELTON Jim	SCHMITTOU Tom	HABU	4
06/02/73	975	12:00	JUDKINS Ty	MORGAN George	HABU	1.9
07/02/73	961	09:15	SHELTON Jim	SCHMITTOU Tom	K10	2.2
07/02/73	963	11:00	GUNTHER Bud	ALLOCCA Tom	HABU	3.5
10/02/73	971	12:00	GUNTHER Bud	ALLOCCA Tom	HABU	4.1
11/02/73	963	13:00	POWELL Bob	COLEMAN Gary	HABU	3.9
13/02/73	971	12:30	JUDKINS Ty	MORGAN George	HABU	4
14/02/73	975	12:00	GUNTHER Bud	ALLOCCA Tom	HABU	4.2
15/02/73	961	10:00	POWELL Bob	COLEMAN Gary	HABU	5.2
16/02/73	971	12:00	JUDKINS Ty	MORGAN George	HABU	4.1
17/02/73	975	13:00	GUNTHER Bud	ALLOCCA Tom	HABU	4
18/02/73	963	10:00	POWELL Bob	COLEMAN Gary	HABU	3.7
19/02/73	975	11:00	JUDKINS Ty	MORGAN George	HABU	4
20/02/73	961	10:00	GUNTHER Bud	ALLOCCA Tom	HABU	4
22/02/73	975	10:40	POWELL Bob	COLEMAN Gary	HABU	3.8
23/02/73	975	12:30	JUDKINS Ty	MORGAN George	HABU	3.5
24/02/73	961	11:00	GUNTHER Bad	ALLOCCA Tom	HABU	4
25/02/73	963	10:40	POWELL Bob	COLEMAN Gary	HABU	2.2
27/02/73	975		JUDKINS Ty	MORGAN George	HABU	
27/02/73	963		JUDKINS Ty	MORGAN George	HABU	
27/02/73	975	11:14	GUNTHER Bad	ALLOCCA Tom	HABU	4.1
28/02/73	963	09:45	POWELL Bob	COLEMAN Gary	HABU	1.5
01/03/73	975	10:00	JUDKINS Ty	MORGAN George	HABU	2
01/03/73	963	11:10	GUNTHER Bad	ALLOCCA Tom	HABU	1.7
03/03/73	975	11:00	JUDKINS Ty	MORGAN George	HABU	4
06/03/73	963	12:30	POWELL Bob	COLEMAN Gary	HABU	3.9
07/03/73	971	10:00	JUDKINS Ty	MORGAN George	K3	2.4
08/03/73	963	12:30	GUNTHER Bad	ALLOCCA Tom	HABU	3.6
10/03/73	963	10:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.6
11/03/73	971	12:00	POWELL Bob	COLEMAN Gary	HABU	2.6
13/03/73	975	09:15	GUNTHER Bad	ALLOCCA Tom	HABU	4.3
14/03/73	971	10:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.6
18/03/73	961	14:00	RANSOM Lee	GERSTEN Mark	HABU	3.6
19/03/73	975	11:50	RANSOM Lee	GERSTEN Mark	HABU	4.2
23/03/73	971	10:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.9
26/03/73	961	08:20	RANSOM Lee	GERSTEN Mark	HABU	2.3
26/03/73	971	10:00	ADAMS Buck	MACHOREK Bill	K9	2.4
27/03/73	961	11:00	ADAMS Buck	MACHOREK Bill	HABU	4
30/03/73	971	12:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3
31/03/73	975	09:45	RANSOM Lee	GERSTEN Mark	HABU	3.7
03/04/73	971	10:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.9
04/04/73	963	12:00	SULLIVAN Jim	WIDDIFIELD Noel	K4	0.8
04/04/73	961	10:00	ADAMS Buck	MACHOREK Bill	HABU	3.7
06/04/73	961	09:10	ADAMS Buck	MACHOREK Bill	HABU	4.5
08/04/73	961	12:30	BLEDSOE Pat	BLACKWELL Reggie	HABU	3.2
09/04/73	975	10:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	0.6
09/04/73	971	10:35	ADAMS Buck	MACHOREK Bill	HABU	4.4
11/04/73	963	12:50	BLEDSOE Pat	BLACKWELL Reggie	HABU	3.5
12/04/73	975	08:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.8
14/04/73	963	10:45	ADAMS Buck	MACHOREK Bill	HABU	2.2
14/04/73	961	12:15	BLEDSOE Pat	BLACKWELL Reggie	HABU	0.4
16/04/73	971	12:15	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.9
18/04/73	961	07:05	BLEDSOE Pat	BLACKWELL Reggie	HABU	2.3
19/04/73	971	12:00	ADAMS Buck	MACHOREK Bill	HABU	4.1
22/04/73	963	11:44	CUNNINCHAM Bob	FAGG Jimmy	HABU	5.3
24/04/73	963	11:45	BLEDSOE Pat	BLACKWELL Reggie	HABU	5.5
26/04/73	961	14:00	ADAMS Buck	MACHOREK Bill	HABU	3.5
28/04/73	971	09:15	CUNNINCHAM Bob	FAGG Jimmy	HABU	3.5
30/04/73	963	10:00	BLEDSOE Pat	BLACKWELL Reggie	HABU	3.5
01/05/73	975	10:00	ADAMS Buck	MACHOREK Bill	K5	2.2
05/05/73	975	12:25	CUNNINCHAM Bob	FAGG Jimmy	K5	2
06/05/73	961	09:46	RANSOM Lee	GERSTEN Mark	K4	1
07/05/73	975	12:00	ADAMS Buck	MACHOREK Bill	HABU	3
08/05/73	975	18:30	ADAMS Buck	MACHOREK Bill	N-RTB FERRY	2.3
11/05/73	971	10:00	CUNNINCHAM Bob	FAGG Jimmy	K4	1.1
12/05/73	971	10:00	CUNNINCHAM Bob	FAGG Jimmy	HABU	4.3
13/05/73	963	10:25	RANSOM Lee	GERSTEN Mark	HABU	4
16/05/73	963	09:40	CUNNINCHAM Bob	FAGG Jimmy	HABU	3.8
17/05/73	975	13:30	RANSOM Lee	GERSTEN Mark	2.6	A
19/05/73	971	10:30	HERTZOG Randy	CARNOCHAN John	HABU	4.3
19/05/73	963	13:30	CUNNINCHAM Bob	FAGG Jimmy	HABU	1.8
20/05/73	961	11:30	RANSOM Lee	GERSTEN Mark	HABU	3.1
23/05/73	975	11:00	HERTZOG Randy	CARNOCHAN John	K3	2.2
24/05/73	961	10:00	RANSOM Lee	GERSTEN Mark	HABU	2
27/05/73	963	12:15	CUNNINCHAM Bob	FAGG Jimmy	HABU	4.3
28/05/73	971	10:00	HERTZOG Randy	CARNOCHAN John	K4	1
30/05/73	961	10:45	HERTZOG Randy	CARNOCHAN John	HABU	2.3
30/05/73	975	11:45	RANSOM Lee	GERSTEN Mark	K5	2.2
31/05/73	971	12:30	JUDKINS Ty	MORGAN George	K4	1
01/06/73	961		CUNNINCHAM Bob	FAGG Jimmy	HABU	
01/06/73	975	13:58	RANSOM Lee	GERSTEN Mark	HABU	3.1
03/06/73	971	10:00	HERTZOG Randy	CARNOCHAN John	HABU	3.9
04/06/73	975	06:00	CUNNINCHAM Bob	FAGG Jimmy	FERRY OUT	
06/06/73	962	03:00	BLEDSOE Pat	BLACKWELL Reggie	FERRY IN (OL-KA)	5.3
07/06/73	961	06:00	BLEDSOE Pat	BLACKWELL Reggie	FERRY OUT	
08/06/73	963	09:30	BLEDSOE Pat	BLACKWELL Reggie	HABU	4
08/06/73	962	10:00	JUDKINS Ty	MORGAN George	K5	2.1
09/06/73	972	03:00	ADAMS Buck	MACHOREK Bill	FERRY TO OL-KA	5.3
10/06/73	971	06:00	RANSOM Lee	GERSTEN Mark	FERRY OUT	
11/06/73	972	11:00	HERTZOG Randy	CARNOCHAN John	HABU	3.6
12/06/73	968	03:08	HELT Bob	ELLIOTT Larry	FERRY TO OL-KA	5.5
13/06/73	963	06:00	ADAMS Buck	MACHOREK Bill	FERRY OUT	
14/06/73	972	10:00	JUDKINS Ty	MORGAN George	HABU	0.6
14/06/73	968	10:19	HELT Bob	ELLIOTT Larry	K9	2.3
15/06/73	968	07:00	JUDKINS Ty	MORGAN George	HABU	3.5

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
16/06/73	972	10:00	HERTZOG Randy	CARNOCHAN John	K9	2.5
19/06/73	962	10:00	HELT Bob	ELLIOTT Larry	K9	3.9
20/06/73	968	11:15	JUDKINS Ty	MORGAN George	HABU	4.3
21/06/73	972	10:00	HERTZOG Randy	CARNOCHAN John	K5	1.8
22/06/73	968	16:00	HERTZOG Randy	CARNOCHAN John	HABU	2.2
23/06/73	962	12:20	HELT Bob	ELLIOTT Larry	HABU	3.3
24/06/73	968		JUDKINS Ty	MORGAN George	K4	
24/06/73	972	11:30	HERTZOG Randy	CARNOCHAN John	HABU	3.9
26/06/73	972	10:00	JUDKINS Ty	MORGAN George	K9	2.1
28/06/73	962	10:10	JUDKINS Ty	MORGAN George	HABU	3.9
29/06/73	968	10:25	HELT Bob	ELLIOTT Larry	HABU	3.5
02/07/73	972	10:00	GUNTHER Bud	ALLOCCA Tom	K9	2.1
05/07/73	962	11:30	JUDKINS Ty	MORGAN George	HABU	2.2
05/07/73	968	11:00	HELT Bob	ELLIOTT Larry	HABU	1.6
06/07/73	962		JUDKINS Ty	MORGAN George	RTB FERRY	
07/07/73	972	12:00	GUNTHER Bud	ALLOCCA Tom	HABU	2
07/07/73	962	18:00	JUDKINS Ty	MORGAN George	N-RTB FERRY	2.4
10/07/73	972	10:10	HELT Bob	ELLIOTT Larry	K9/5	2.1
11/07/73	962	12:00	GUNTHER Bud	ALLOCCA Tom	HABU	3.6
13/07/73	972	09:30	JOERSZ Al	FULLER John	K3	2.3
13/07/73	962	14:15	HELT Bob	ELLIOTT Larry	HABU	3.6
21/07/73	968	13:30	JOERSZ Al	FULLER John	HABU	3.3
22/07/73	962	11:10	HELT Bob	ELLIOTT Larry	HABU	3.6
24/07/73	972	11:00	GUNTHER Bud	ALLOCCA Tom	K4	1
25/07/73	962	14:30	JOERSZ Al	FULLER John	HABU	3.5
27/07/73	972	09:30	SHELTON Jim	COLEMAN Gary	HABU	3.8
29/07/73	968	11:00	GUNTHER Bud	ALLOCCA Tom	HABU	3.5
31/07/73	962	09:30	JOERSZ Al	FULLER John	HABU	3.9
02/08/73	968	14:30	SHELTON Jim	COLEMAN Gary	HABU	3.6
03/08/73	962	10:30	GUNTHER Bud	ALLOCCA Tom	HABU	3.1
04/08/73	972		WILSON Jim	DOUGLASS Burce	K10	
05/08/73	968	10:08	WILSON Jim	DOUGLASS Burce	K10	2.4
07/08/73	972	11:00	JOERSZ Al	FULLER John	HABU	1.9
07/08/73	968	12:41	SHELTON Jim	COLEMAN Gary	HABU	3.9
10/08/73	962	13:10	JOERSZ Al	FULLER John	HABU	3.5
17/08/73	968	13:00	JOERSZ Al	FULLER John	HABU	3.9
17/08/73	962	14:50	WILSON Jim	DOUGLASS Burce	K9	2.3
19/08/73	972		ADAMS Buck	MACHOREK Bill	K11	
19/08/73	972	14:40	ADAMS Buck	MACHOREK Bill	K4	1.1
20/08/73	962	14:00	SHELTON Jim	COLEMAN Gary	HABU	3.6
24/08/73	972	13:00	WILSON Jim	DOUGLASS Burce	HABU	4.2
26/08/73	968		ADAMS Buck	MACHOREK Bill	K11B	
28/08/73	962	10:00	ADAMS Buck	MACHOREK Bill	K11B	2.3
28/08/73	968	11:00	SHELTON Jim	COLEMAN Gary	K11A	2.1
30/08/73	962		WILSON Jim	DOUGLASS Burce	HABU	
30/08/73	972	14:07	WILSON Jim	DOUGLASS Burce	HABU	3.5
31/08/73	968	10:00	ADAMS Buck	MACHOREK Bill	K6	2.7
03/09/73	962	10:00	WILSON Jim	DOUGLASS Burce	K11B	2.2
04/09/73	972	10:00	ADAMS Buck	MACHOREK Bill	K11C	2.2
06/09/73	962	11:00	WILSON Jim	DOUGLASS Burce	HABU	4.5
07/09/73	972	12:00	ADAMS Buck	MACHOREK Bill	HABU	3.5
09/09/73	972	09:30	ADAMS Buck	MACHOREK Bill	HABU	3.7
10/09/73	968	10:00	SULLIVAN Jim	WIDDIFIELD Noel	K11	2.3
11/09/73	968	12:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.5
13/09/73	972	10:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.9
15/09/73	962	10:00	WILSON Jim	DOUGLASS Bruce	K11A	2.4
18/09/73	972	07:00	WILSON Jim	DOUGLASS Bruce	K13	2.1
20/09/73	962	13:15	ADAMS Buck	MACHOREK Bill	HABU	3.4
23/09/73	962	11:55	SULLIVAN Jim	WIDDIFIELD Noel	K4	09
26/09/73	968	10:00	ADAMS Buck	MACHOREK Bill	K12	3.8
27/09/73	962	13:30	BLEDSOE Pat	BLACKWELL Reggie	HABU	3.5
30/09/73	968	10:00	SULLIVAN Jim	WIDDIFIELD Noel	K12	3.4
02/10/73	968		SULLIVAN Jim	WIDDIFIELD Noel	HABU	
02/10/73	962	11:00	ADAMS Buck	MACHOREK Bill	HABU	0.8
04/10/73	972	09:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.9
05/10/73	962	13:30	BLEDSOE Pat	BLACKWELL Reggie	HABU	3.6
07/10/73	972	13:03	RANSOM Lee	ALLOCCA Tom	K12	2
08/10/73	968	13:12	SULLIVAN Jim	WIDDIFIELD Noel	HABU	1.9
10/10/73	968	10:00	BLEDSOE Pat	BLACKWELL Reggie	K11B	3.3
12/10/73	972		RANSOM Lee	ALLOCCA Tom	K12	
13/10/73	962		SULLIVAN Jim	WIDDIFIELD Noel	KA	
13/10/73	972	13:07	RANSOM Lee	ALLOCCA Tom	K11B	1
13/10/73	962	13:28	SULLIVAN Jim	WIDDIFIELD Noel	K4	1
15/10/73	968	13:17	RANSOM Lee	ALLOCCA Tom	HABU	2.5
17/10/73	972	10:06	BLEDSOE Pat	BLACKWELL Reggie	K9	2.2
18/10/73	968	13:30	BLEDSOE Pat	BLACKWELL Reggie	HABU	3.6
19/10/73	962	10:00	HERTZOG Randy	CARNOCHAN John	K9	2.4
21/10/73	968	09:30	BLEDSOE Pat	BLACKWELL Reggie	HABU	4.1
23/10/73	972	10:09	RANSOM Lee	ALLOCCA Tom	K9	2.2
25/10/73	962	10:00	HERTZOG Randy	CARNOCHAN John	K9	1.8
28/10/73	972	10:00	BLEDSOE Pat	BLACKWELL Reggie	K9	2.3
29/10/73	962		RANSOM Lee	ALLOCCA Tom	K9	

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
30/10/73	968	11:00	RANSOM Lee	ALLOCCA Tom	HABU	4
31/10/73	972	14:00	RANSOM Lee	ALLOCCA Tom	K9	2.2
01/11/73	962	10:00	HERTZOG Randy	CARNOCHAN John	K9	1.8
03/11/73	972	12:30	JUDKINS Ty	MORGAN George	HBU	3.5
06/11/73	962	10:00	HERTZOG Randy	CARNOCHAN John	K9	2.3
08/11/73	968	12:00	RANSOM Lee	ALLOCCA Tom	HABU	4.1
08/11/73	972	15:45	JUDKINS Ty	MORGAN George	K4	0.9
12/11/73	962	10:00	HERTZOG Randy	CARNOCHAN John	K9	2.2
14/11/73	972	10:00	RANSOM Lee	ALLOCCA Tom	HABU	K9
14/11/73	968	11:00	JUDKINS Ty	MORGAN George	K9	2.1
17/11/73	962	10:00	HELT Bob	ELLIOTT Larry	K12	3.4
18/11/73	968	12:10	HELT Bob	ELLIOTT Larry	HABU	3.6
19/11/73	972	11:30	HERTZOG Randy	CARNOCHAN John	HABU	4.2
21/11/73	968	10:00	JUDKINS Ty	MORGAN George	HABU	4.4
22/11/73	962	12:30	HERTZOG Randy	CARNOCHAN John	HABU	3.6
26/11/73	968	10:00	HELT Bob	ELLIOTT Larry	K4	1.4
28/11/73	962	11:15	HELT Bob	ELLIOTT Larry	HABU	3.9
29/11/73	968	12:20	JUDKINS Ty	MORGAN George	HABU	3.6
02/12/73	972	10:10	HELT Bob	ELLIOTT Larry	K9	2.5
03/12/73	962	11:00	JUDKINS Ty	MORGAN George	HABU	4.1
04/12/73	962	11:15	SHELTON Jim	COLEMAN Gary	HABU	4.8
05/12/73	968	09:30	HELT Bob	ELLIOTT Larry	K9	2.5
07/12/73	968	10:15	HELT Bob	ELLIOTT Larry	K10	2.5
08/12/73	962	09:30	HELT Bob	ELLIOTT Larry	HABU	4.1
10/12/73	962	11:30	JUDKINS Ty	MORGAN George	HABU	4.8
11/12/73	972	10:00	SHELTON Jim	COLEMAN Gary	K4	1
16/12/73	972	13:23	SHELTON Jim	COLEMAN Gary	HABU	0.5
17/12/73	972	12:15	SHELTON Jim	COLEMAN Gary	HABU	4.2
18/12/73	968	10:00	JOERSZ Al	FULLER John	K9	0.8
19/12/73	972	12:15	JOERSZ Al	FULLER John	HABU	4.9
21/12/73	968	10:00	HELT Bob	ELLIOTT Larry	K9	1.5
26/12/73	962	10:00	JOERSZ Al	FULLER John	K9	2.1
27/12/73	962	10:06	SHELTON Jim	COLEMAN Gary	K9	2.6
28/12/73	972	12:15	JOERSZ Al	FULLER John	HABU	3.5
29/12/73	968	10:00	WILSON Jim	DOUGLASS Bruce	K9	2.5
31/12/73	972	11:15	JOERSZ Al	FULLER John	HABU	4.2
03/01/74	962	10:00	WILSOM Jim	DOUGLASS Bruce	K9	1.8
04/01/74	972	11:45	SHELTON Jim	COLEMAN Gary	HABU	4.9
06/01/74	968	10:00	JOERSZ Al	FULLER John	K9	2.6
08/01/74	972	10:30	WILSON Jim	DOUGLASS Bruce	HABU	4.1
09/01/74	962	10:00	JOERSZ Al	FULLER John	K9	2.6
12/01/74	968	11:00	WILSON Jim	DOUGLASS Bruce	HABU	3.6
14/01/74	972	11:20	SULLIVAN Jim	WIDDIFIELD Noel	K9	2.5
15/01/74	962	11:00	ROSENBERG Maury	BULLUCH Don	K9	2.5
17/01/74	968	10:11	ROSENBERG Maury	BULLUCH Don	K1	3.7
18/01/74	972	10:00	WILSON Jim	DOUGLASS Bruce	K9	2.6
19/01/74	972	12:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.8
22/01/74	972	12:00	WILSON Jim	DOUGLASS Bruce	K9	2.4
23/01/74	968	10:31	ROSENBERG Maury	BULLUCH Don	K9	2.6
24/01/74	962	11:30	WILSON Jim	DOUGLASS Bruce	HABU	4.1
25/01/74	968	10:00	ROSENBERG Maury	BULLUCH Don	K9	1.4
28/01/74	968	13:10	ROSENBERG Maury	BULLUCH Don	K9	2.4
30/01/74	972	12:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.5
31/01/74	968	10:00	WILSON Jim	DOUGLASS Bruce	K9	2.3
02/02/74	962	11:30	WILSON Jim	DOUGLASS Bruce	HABU	4.1
04/02/74	968	09:45	ROSENBERG Maury	BULLUCH Don	K9	2.5
05/02/74	968	10:00	ROSENBERG Maury	BULLUCH Don	K1	1.4
06/02/74	962	10:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.8
07/02/74	968	10:00	ROSENBERG Maury	BULLUCH Don	K1	3.7
10/02/74	962	12:15	ADAMS Buck	MACHOREK Bill	HABU	3.6
11/02/74	972	10:05	ROSENBERG Maury	BULLUCH Don	K1	4.1
13/02/74	962	12:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	1.9
15/02/74	962	11:55	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.9
18/02/74	968	12:30	ADAMS Buck	MACHOREK Bill	HABU	3.5
19/02/74	972	10:00	RANSOM Lee	ALLOCCA Tom	K9	2.3
22/02/74	968		RANSOM Lee	ALLOCCA Tom	HABU	
23/02/74	962		RANSOM Lee	ALLOCCA Tom	HABU	
25/02/74	968	11:30	RANSOM Lee	ALLOCCA Tom	HABU	3.7
26/02/74	972	10:15	BLEDSOE Pat	BLACKWELL Reggie	K9	2.4
27/02/74	968	09:05	ADAMS Buck	MACHOREK Bill	HABU	3.6
02/03/74	962	12:00	BLEDSOE Pat	BLACKWELL Reggie	HABU	4.4
04/03/74	962		RANSOM Lee	ALLOCCA Tom	K9	
05/03/74	962	10:17	RANSOM Lee	ALLOCCA Tom	K9	2.2
06/03/74	972	10:20	ADAMS Buck	MACHOREK Bill	K9	1.1
07/03/74	962	12:00	RANSOM Lee	ALLOCCA Tom	HABU	1.1
08/03/74	968	09:30	RANSOM Lee	ALLOCCA Tom	HABU	3.7
11/03/74	972	11:00	ADAMS Buck	MACHOREK Bill	HABU	4.4
12/03/74	962	13:15	RANSOM Lee	ALLOCCA Tom	K4	0.9
12/03/74	972	12:15	BLEDSOE Pat	BLACKWELL Reggie	HABU	4.3
16/03/74	968	10:00	JUDKINS Ty	MORGAN George	K9	2.4
18/03/74	962	12:00	RANSOM Lee	ALLOCCA Tom	HABU	3.5
19/03/74	972		BLEDSOE Pat	BLACKWELL Reggie	K9	

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
20/03/74	972	09:45	BLEDSOE Pat	BLACKWELL Reggie	K9	2.3
25/03/74	962	10:00	HELT Bob	ELLIOTT Larry	K9	2.4
26/03/74	968	13:00	JUDKINS Ty	MORGAN George	K9	2.1
27/03/74	972	10:00	JUDKINS Ty	MORGAN George	HABU	3.7
28/03/74	972	13:00	BLEDSOE Pat	BLACKWELL Reggie	HABU	4.3
31/03/74	972	12:15	HELT Bob	ELLIOTT Larry	HABU	3.8
04/04/74	962	13:00	BLEDSOE Pat	BLACKWELL Reggie	K4	1.1
05/04/74	972	11:30	JUDKINS Ty	MORGAN George	HABU	4.8
07/04/74	962	10:30	BLEDSOE Pat	BLACKWELL Reggie	HABU	4.1
10/04/74	972	09:45	HELT Bob	ELLIOTT Larry	K9	2.8
11/04/74	962	11:00	HELT Bob	ELLIOTT Larry	HABU	5
13/04/74	972	10:00	HERTZOG Randy	CARNOCHAN John	K9	2.4
16/04/74	962	09:46	JUDKINS Ty	MORGAN George	K9	2.4
20/04/74	972	11:30	HERTZOG Randy	CARNOCHAN John	HABU	3.7
22/04/74	968	10:00	JOERSZ Al	FULLER John	D1	1.3
23/04/74	962	10:00	HELT Bob	ELLIOTT Larry	D1	1.2
27/04/74	968	12:20	JOERSZ Al	FULLER John	D3	2
29/04/74	972	14:30	HELT Bob	ELLIOTT Larry	HABU	3.9
30/04/74	968	10:00	HERTZOG Randy	CARNOCHAN John	D3	2.5
01/05/74	962	12:35	JOERSZ Al	FULLER John	HABU	5
06/05/74	962	11:10	HERTZOG Randy	CARNOCHAN John	HABU	5.1
07/05/74	972	10:00	WILSON Jim	DOUGLASS Bruce	D4	2.7
10/05/74	972	10:00	JOERSZ Al	FULLER John	HABU	3.9
13/05/74	962	10:00	HERTZOG Randy	CARNOCHAN John	D6	2.4
14/05/74	962	13:35	WILSON Jim	DOUGLASS Bruce	D4	2.8
17/05/74	968	11:03	WILSON Jim	DOUGLASS Bruce	HABU	3.7
18/05/74	962	10:05	JOERSZ Al	FULLER John	D4	2.4
19/05/74	968	09:30	JOERSZ Al	FULLER John	HABU	3.7
20/05/74	962	18:50	WILSON Jim	DOUGLASS Bruce	D1	1
22/05/74	968	10:00	ROSENBERG Maury	BULLUCH Don	D4	2.4
27/05/74	968	10:45	ROSENBERG Maury	BULLUCH Don	HABU	5.1
28/05/74	962	10:00	JOERSZ Al	FULLER John	D3	2.5
03/06/74	972	10:15	WILSON Jim	DOUGLASS Bruce	D5	2.1
04/06/74	962	09:45	SULLIVAN Jim	WIDDIFIELD Noel	D4	2.5
05/06/74	968	10:05	WILSON Jim	DOUGLASS Bruce	HABU	2.3
06/06/74	972	10:20	ROSENBERG Maury	BULLUCH Don	D8	4.2
07/06/74	972	10:15	SULLIVAN Jim	WIDDIFIELD Noel	D8	4
10/06/74	968	10:03	WILSON Jim	DOUGLASS Bruce	D8	4.3
11/06/74	968	10:45	ROSENBERG MAURY	BULLUCH Don	D8	4.2
12/06/74	962	10:45	WILSON Jim	DOUGLASS Bruce	D8	4.2
14/06/74	972	13:00	ROSENBERG Maury	BULLUCH Don	HABU	2
15/06/74	972	14:00	ROSENBERG Maury	BULLUCH Don	HABU	4.7
17/06/74	962	09:00	ADAMS Buck	MACHOREK Bill	D8	3.9
18/06/74	972	09:02	SULLIVAN Jim	WIDDIFIELD Noel	D7	2
21/06/74	962		ROSENBERG Maury	BULLUCH Don	D8	
22/06/74	972	11:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.6
24/06/74	962	10:00	ROSENBERG Maury	BULLUCH Don	D8	2.3
25/06/74	972	10:04	ADAMS Buck	MACHOREK Bill	D8	4
26/06/74	972		SULLIVAN Jim	WIDDIFIELD Noel	D8	
27/06/74	962	13:44	ADAMS Buck	MACHOREK Bill	HABU	1.8
25/06/74	972	13:30	ADAMS Buck	MACHOREK Bill	HABU	1.3
29/06/74	972	11:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.6
02/07/74	968	10:06	HBLT Bob	ELLIOTT Larry	D8	2
03/07/74	962	10:20	ADAMS Buck	MACHOREK Bill	D8	2.1
08/07/74	972	11:00	HELT Bob	ELLIOTT Larry	HABU	3
09/07/74	962	10:00	SULLIVAN Jim	WIDDIFIELD Noel	D3	2.2
10/07/74	962	11:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.1
11/07/74	968	10:05	ADAMS Buck	MACHOREK Bill	D8	3.9
12/07/74	972		HELT Bob	ELLIOTT Larry	D8	
15/07/74	968	12:10	ADAMS Buck	MACHOREK Bill	HABU	3.6
16/07/74	972	10:30	HELT Bob	ELLIOTT Larry	D8	4.1
19/07/74	968		BLEDSOE Pat	BLACKWELL Reggie	D7	
19/07/74	968	10:30	BLEDSOE Pat	BLACKWELL Reggie	D1	1.1
23/07/74	968	11:03	HELT Bob	ELLIOTT Larry	HABU	4
24/07/74	972	10:30	ADAMS Buck	MACHOREK Bill	D4	2.3
26/07/74	968	09:10	BLEDSOE Pat	BLACKWELL Reggie	HABU	4.2
29/07/74	972	10:00	HELT Bob	ELLIOTT Larry	HABU	2.1
30/07/74	962	11:23	RANSOM Lee	PAYNE Al	D8	4.1
31/07/74	968	11:00	BLEDSOE Pat	BLACKWELL Reggie	D7	2.3
02/08/74	968	10:15	HELT Bob	ELLIOTT Larry	D8	4.1
06/08/74	972	12:30	RANSOM Lee	PAYNE Al	HABU	1.5
07/08/74	962	10:15	BLEDSOE Pat	BLACKWELL Reggie	D8	4
08/08/74	968	10:30	RANSOM Lee	PAYNE Al	HABU	4
09/08/74	962	12:00	HELT Bob	ELLIOTT Larry	HABU	2.3
09/08/74	968	13:23	BLEDSOE Pat	BLACKWELL Reggie	HABU	4.2
11/08/74	968		RANSOM Lee	PAYNE Al	D4	
12/08/74	968	10:00	HELT Bob	ELLIOTT Larry	D1	1.1
13/08/74	963	03:00	JOERSZ Al	FULLER John	FERRY IN	5.3
13/08/74	972	10:00	RANSOM Lee	PAYNE Al	D3	2.4
14/08/74	968	06:00	HELT Bob	ELLIOTT Larry	FERRY OUT	
15/08/74	962	11:00	BLEDSOE Pat	BLACKWELL Reggie	HABU	3.7

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
15/08/74	963	10:00	JOERSZ Al	FULLER John	D3	2.4
16/08/74	961	03:00	WILSON Jim	DOUGLASS Bruce	FERRY IN	5.3
17/08/74	972	06:00	BLEDSOE Pat	BLACKWELL Reggie	FERRY OUT	
18/08/74	963	12:34	RANSOM Lee	PAYNE Al	HABU	3.4
19/08/74	976	03:00	HERTZOG Randy	MORGAN George	FERRY IN	5.3
20/08/74	962	06:00	WILSON Jim	DOUGLASS Bruce	FERRY OUT	
20/08/74	961	09:30	JOERSZ Al	FULLER John	D3	0.8
22/08/74	963	09:45	RANSOM Lee	PAYNE Al	HABU	1.5
22/08/74	976	11:00	JOERSZ Al	FULLER John	HABU	1.7
23/08/74	963	09:45	RANSOM Lee	PAYNE Al	HABU	4.3
26/08/74	976	10:00	HERTZOG Randy	MORGAN George	D4	2.3
26/08/74	961	10:35	JOERSZ Al	FULLER John	HABU	4.8
27/08/74	963	10:00	RANSOM Lee	PAYNE Al	D1	1.1
28/08/74	976	10:15	HERTZOG Randy	MORGAN George	D4	1.5
03/09/74	976	10:15	JOERSZ Al	FULLER John	D8	4.1
04/09/74	961	10:17	RANSOM Lee	PAYNE Al	D1	1
04/09/74	963	10:30	HERTZOG Randy	MORGAN George	D3	2.4
05/09/74	963	10:30	HERTZOG Randy	MORGAN George	HABU	4.9
09/09/74	976	10:52	ROSENBERG Maury	BULLUCH Don	D8	4
10/09/74	963	10:30	JOERSZ Al	FULLER John	HABU	4.9
11/09/74	961	11:55	JOERSZ Al	FULLER John	HABU	4
13/09/74	963	10:45	HERTZOG Randy	MORGAN George	D3	2.4
17/09/74	961	10:32	JOERSZ Al	FULLER John	D3	2.5
19/09/74	976	10:00	ROSENBERG Maury	BULLUCH Don	HABU	4.9
20/09/74	963	10:15	HERTZOG Randy	MORGAN George	D3	2.3
23/09/74	961	10:40	WILSON Jim	DOUGLASS Bruce	D8	4.1
24/09/74	976	10:15	ROSENBERG Maury	BULLUCH Don	D4	1.8
25/09/74	963	10:45	HERTZOG Randy	MORGAN George	HABU	5
27/09/74	961	12:00	HERTZOG Randy	MORGAN George	HABU	2.1
27/09/74	963	13:24	ROSENBERG Maury	BOLLUCH Don	HABU	4.3
02/10/74	963	10:14	WILSON Jim	DOUGLASS Bruce	D2	2.5
04/10/74	961	10:13	ROSENBERG Maury	BULLUCH Don	D1	1.2
09/10/74	961	11:45	ROSENBERG Maury	BULLUCH Don	HABU	3.7
10/10/74	963	10:34	WILSON Jim	DOUGLASS Bruce	D8	3.6
12/10/74	963	12:30	WILSON Jim	DOUGLASS Bruce	HABU	4.2
15/10/74	963		ADAMS Buck	MACHOREK Bill	D4	
16/10/74	961	11:44	WILSON Jim	DOUGLASS Bruce	HABU	5.1
17/10/74	963		ADAMS Buck	MACHOREK Bill	D4	
18/10/74	961	12:27	ROSENBERG Maury	BULLUCH Don	D7	1.8
18/10/74	963	10:34	ADAMS Buck	MACHOREK Bill	HABU	4.1
22/10/74	961	10:15	WILSON Jim	DOUGLASS Bruce	D3	2.5
26/10/74	963	12:50	ADAMS Buck	MACHOREK Bill	HABU	3.7
28/10/74	963	12:50	WILSON Jim	DOUGLASS Bruce	HABU	3.8
29/10/74	961	10:15	SULLIVAN Jim	WIDDIFIELD Noel	D3	2.4
01/11/74	963		SULLIVAN Jim	WIDDIFIELD Noel	HABU	
02/11/74	963	10:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.6
11/11/74	961	13:15	HELT Bob	ELLIOTT Larry	D3	2.5
12/11/74	963	10:35	SULLIVAN Jim	WIDDIFIELD Noel	D3	2.3
13/11/74	961	11:00	HELT Bob	ELLIOTT Larry	HABU	5.1
15/11/74	963	13:30	SULLIVAN Jim	WIDDIFIELD Noel	D3	2.4
17/11/74	961	10:00	RANSOM Lee	PAYNE Al	D8	2.6
23/11/74	963	11:30	HELT Bob	ELLIOTT Larry	HABU	4.2
25/11/74	963	13:00	RANSOM Lee	PAYNE Al	D8	3.9
26/11/74	971	03:31	BLEDSOE Pat	BLACKWELL Reggie	FERRY IN (DET-1)	5.5
28/11/74	963	11:30	HELT Bob	ELLIOTT Larry	HABU	4.2
29/11/74	961	10:50	RANSOM Lee	PAYNE Al	D3	2.5
02/12/74	971	10:31	BLEDSOE Pat	BLACKWELL Reggie	D8	1.5
03/12/74	961	11:30	BLEDSOE Pat	BLACKWELL Reggie	HABU	4.4
04/12/74	971	10:15	HELT Bob	ELLIOTT Larry	D8	1.4
06/12/74	961	10:45	RANSOM Lee	PAYNE Al	HABU	5
09/12/74	971	12:00	HELT Bob	ELLIOTT Larry	D8	2
10/12/74	971		BLEDSOE Pat	BLACKWELL Reggie	D9	
11/12/74	971	11:15	BLEDSOE Pat	BLACKWELL Reggie	D1	1.1
11/12/74	963	10:10	HELT Bob	ELLIOTT Larry	HABU	3.7
13/12/74	971	10:15	RANSOM Lee	PAYNE Al	D9	2.7
17/12/74	971	12:00	KINEGO Joe	JACKS Roger	D3	2.5
19/12/74	963		BLEDSOE Pat	BLACKWELL Reggie	HABU	
20/12/74	961	10:30	BLEDSOE Pat	BLACKWELL Reggie	D8	3.8
21/12/74	963		BLEDSOE Pat	BLACKWELL Reggie	HABU	
23/12/74	961	10:50	RANSOM Lee	PAYNE Al	D1	1
23/12/74	963	09:30	BLEDSOE Pat	BLACKWELL Reggie	HABU	3.7
27/12/74	971	11:30	KINEGO Joe	JACKS Roger	D5	3.9
28/12/74	963	11:15	KINEGO Joe	JACKS Roger	HABU	3.7
30/12/74	961	11:30	BLEDSOE Pat	BLACKWELL Reggie	HABU	2.1
30/12/74	971	12:45	KINEGO Joe	JACKS Roger	HABU	1.4
31/12/74	961	11:30	BLEDSOE Pat	BALCKWELL Reggie	HABU	6.2
02/01/75	963	10:30	ROSENBERG Maury	BULLUCH Don	HABU	4.3
03/01/75	961	09:30	ROSENBERG Maury	BULLUCH Don	D4	2.4
04/01/75	961		KINEGO Joe	JACKS Roger	HABU	
04/01/75	963	12:15	ROSENBERG Maury	BULLUCH Don	HABU	4.1
06/01/75	971	10:00	BLEDSOE Pat	BLACKWELL Reggie	D8	4.2
07/01/75	961	10:30	KINEGO Joe	JACKS Roger	HABU	3.3

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
09/01/75	961	10:30	ROSENBERG Maury	BULLUCH Don	HABU	4.3
10/01/75	976	10:00	SMIHT Tom	CARNOCHAN John	FCF	0.7
10/01/75	971	11:30	KINEGO Joe	JACKS Roger	HABU	5
11/01/75	961	11:31	KINEGO Joe	JACKS Roger	HABU	4.1
13/01/75	976		PUGH Tom	CRNOCHAN John	FCF	
13/01/75	976	13:15	PUGH Tom	CARNOCHAN John	FCF	1.4
14/01/75	976	13:30	SMITH Tom	CARNOCHAN John	FCF	2.4
15/01/75	963	11:00	JOERSZ Al	MACHOREK Bill	D9	2.5
16/01/75	971	10:50	ROSENBERG Maury	BULLUCH Don	HABU	5.2
17/01/75	976	13:00	PUGH Tom	CARNOCHAN John	D1	1
17/01/75	961	11:00	JOERSZ Al	MACHOREK Bill	HABU	3.9
23/01/75	963	10:00	KINEGO Joe	MACHOREK Bill	D1	1
24/01/75	961	11:30	JOERSZ Al	MACHOREK Bill	HABU	4.1
25/01/75	963	10:45	ROSENBERG Maury	BULLUCH Don	HABU	4
27/01/75	961	11:00	ROSENBERG Maury	BULLUCH Don	HABU	1.7
28/01/75	961	11:00	HERTZOG Randy	MORGAN George	HABU	1.6
29/01/75	976	11:00	PUGH Tom	CARNOCHAN John	D1	1
29/01/75	963	11:45	JOERSZ Al	MACHOREK Bill	HABU	3.1
30/01/75	976	06:50	PUGH Tom	CARNOCHAN John	FERRY OUT	
31/01/75	971		ROSENBERG Maury	BULLUCH Don	HABU	
31/01/75	961	12:30	HERTZOG Randy	MORGAN George	HABU	4.2
01/02/75	971	10:28	ROSENBERG Maury	BULLUCH Don	D8	4
04/02/75	971	10:32	JOERSZ Al	MACHOREK Bill	D8	4
07/02/75	961	11:15	HERTZOG Randy	MORGAN George	HABU	4.2
08/02/75	963		JOERSZ Al	MACHOREK Bill	HABU	
10/02/75	971		JOERSZ Al	MACHOREK Bill	HABU	
10/02/75	971	12:33	JOERSZ Al	MACHOREK Bill	HABU	4.9
11/02/75	963	10:15	WILSON Jim	DOUGLASS Bruce	D3	2.1
13/02/75	971	10:45	HERTZOG Randy	MORGAN George	HABU	4.9
18/02/75	971	11:20	WILSON Jim	DOUGLASS Bruce	HABU	4.3
18/02/75	961	12:50	JOERSZ Al	MACHOREK Bill	D3	2.3
19/02/75	963	10:15	HERTZOG Randy	MORGAN George	D1	1.1
24/02/75	961	12:00	HERTZOG Randy	MORGAN George	HABU	4.3
25/02/75	971	11:30	WILSON Jim	DOUGLASS Bruce	HABU	3.8
28/02/75	971	11:05	ADAMS Buck	GERSTEN Mark	HABU	4.8
04/03/75	961	12:15	HERTZOG Randy	MORGAN George	D3	2.4
06/03/75	971	12:00	WILSON Jim	DOUGLASS Bruce	HABU	4.2
07/03/75	961	12:00	WILSON Jim	DOUGLASS Bruce	HABU	5
09/03/75	963	09:00	SULLIVAN Jim	WIDDIFIELD Noel	D1	1.1
10/03/75	963	12:38	ADAMS Buck	GERSTEN Mark	D8 MODIFIED	2.5
12/03/75	961	11:00	ADAMS Buck	GERSTEN Mark	HABU	0.6
13/03/75	971		ADAMS Buck	GERSTEN Mark	HABU	
14/03/75	971		ADAMS Buck	GERSTEN Mark	HABU	
14/03/75	971	13:10	ADAMS Buck	GERSTEN Mark	HABU	4.1
15/03/75	971	12:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.9
17/03/75	963	11:00	WILSON Jim	DOUGLASS Bruce	D8	4.1
19/03/75	961	11:00	ADAMS Buck	GERSTEN Mark	D8	2.2
20/03/75	963	11:00	SULLIVAN Jim	WIDDIFIELD Noel	D1	1.1
21/03/75	971	11:15	ADAMS Buck	GERSTEN Mark	HABU	5
22/03/75	963	10:16	SULLIVAN Jim	WIDDIFIELD Noel	D1	0.9
24/03/75	961	10:15	RANSOM Lee	PAYNE Al	D3	1.3
25/03/75	963	10:45	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.8
26/03/75	963	13:10	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.3
27/03/75	963	12:00	RANSOM Lee	PAYNE Al	HABU	4
28/03/75	963	11:30	ADAMS Buck	GERSTEN Mark	HABU	3.5
28/03/75	971	11:00	SULLIVAN Jim	WIDDIFIELD Noel	D1	0.8
01/04/75	971	11:30	ADAMS Buck	GERSTEN Mark	HABU	4
02/04/75	961	11:37	RANSOM Lee	PAYNE Al	D1	1
03/04/75	963		RANSOM Lee	PAYNE Al	HABU	
03/04/75	963	12:12	RANSOM Lee	PAYNE Al	HABU	4.9
04/04/75	961	10:30	SULLIVAN Jim	WIDDIFIELD Noel	D3	2.2
05/04/75	971	12:00	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.2
07/04/75	961		HELT Bob	ELLIOTT Larry	D1	
09/04/75	971	11:00	HELT Bob	ELLIOTT Larry	D8	3.9
10/04/75	963	11:20	RANSOM Lee	PAYNE Al	HABU	4.9
11/04/75	961	10:15	SULLIVAN Jim	WIDDIFIELD Noel	D1	0.9
12/04/75	961	10:00	HELT Bob	ELLIOTT Larry	HABU	0.9
13/04/75	961	11:01	HELT Bob	ELLIOTT Larry	HABU	3.6
15/04/75	971	09:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	4.4
16/04/75	963	11:30	SULLIVAN Jim	WIDDIFIELD Noel	HABU	3.5
17/04/75	971	10:15	RANSOM Lee	PAYNE Al	HABU	1
17/04/75	963	11:15	HELT Bob	ELLIOTT Larry	HABU	3.5
19/04/75	963		RANSOM Lee	PAYNE Al	HABU	
19/04/75	971	11:20	RANSOM Lee	PAYNE Al	HABU	0.9
21/04/75	963	10:00	RANSOM Lee	PAYNE Al	HABU	4.4
22/04/75	961	10:33	CIRINO AL	LIEBMAN Bruce	D1	2.5
23/04/75	963	09:10	CIRINO AL	LIEBMAN Bruce	HABU	0.6
24/04/75	961		CIRINO Al	LIEBMAN Bruce	HABU	
24/04/75	961	10:50	CIRINO Al	LIEBMAN Bruce	HABU	4.4
25/04/75	963	10:00	HELT Bob	ELLIOTT Larry	HABU	3.3
26/04/75	971	09:05	RANSON Lee	PAYNE Al	HABU	4.5
27/04/75	971	10:30	CIRINO Al	LIEBMAN Bruce	HABU	3.5
27/04/75	963	22:40	HELT Bob	ELLIOTT Larry	RTH FERRY NITE	2

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
28/04/75	971	09:50	RANSON Lee	PAYNE Al	HABU	3.4
29/04/75	961	10:09	HELT Bob	ELLIOTT Larry	HABU	3.4
30/04/75	971	09:30	CIRINO Al	LIEBMAN Bruce	HABU	3.5
06/05/75	963	10:20	BLEDSOE Pat	BLACKWELL Reggie	D3	2.2
07/05/75	961	11:40	HELT Bob	ELLIOTT Larry	D4	2.3
09/05/75	963	11:30	HELT Bob	ELLIOTT Larry	HABU	1.6
10/05/75	961	11:30	CIRINO Al	LIEBMAN Bruce	HABU	3.8
11/05/75	971	10:30	CIRINO Al	LIEBMAN Bruce	D1	0.9
11/05/75	961	08:30	HELT Bob	ELLIOTT Larry.	HABU	4.2
15/05/75	963	11:20	BLEDSOE Pat	BLACKWELL Reggie	D1	1.1
17/05/75	963	09:30	KINEGO Joe	JACKS Roger	D1	1
19/05/75	961	08:30	CIRINO Al	LIEBMAN Bruce	HABU	7.4
20/05/75	961	12:20	BLEDSOE Pat	BLACKWELL Reggie	HABU	5.1
22/05/75	961	09:50	BLEDSOE Pat	BLACKWELL Reggie	HABU	4.1
24/05/75	961	12:00	CIRINO Al	LIEBMAN Bruce	HABU	0.5
26/05/75	963	10:30	CIRINO Al	LIEBMAN Bruce	HABU	2.2
27/05/75	971	10:35	KINEGO Joe	JACKS Roger	D9	1.2
28/05/75	961	10:30	CIRINO Al	LIEBMAN Bruce	HABU	2.4
30/05/75	963	11:01	KINEGO Joe	JACKS Roger	HABU	3.9
02/06/75	971		RANSOM Lee	PAYNE Al	D9	
03/06/75	963	11:00	BLEDSOE Pat	BLACKWELL Reggie	HABU	3.7
03/06/75	971	11:40	RANSOM Lee	PAYNE Al	D4	2.4
06/06/75	971		KINEGO Joe	JACKS Roger	D8	
08/06/75	971	05:02	KINEGO Joe	JACKS Roger	D4	1.9
10/06/75	971	11:32	BLEDSOE Pat	BLACKWELL Reggie	D4	1.9
13/06/75	961	09:16	RANSOM Lee	PAYNE Al	D4	1.9
13/06/75	963	10:10	KINEGO Joe	JACKS Roger	HABU	5
16/06/75	971	10:15	WILSON Jim	DOUGLASS Bruce	D3	2.6
17/06/75	963	10:15	JOERSZ AL	MORGAN George	D4	2.4
18/06/75	961		KINEGO Joe	JACKS Roger	D4	A
19/06/75	963	10:15	WILSON Jim	DOUGLASS Bruce	D6	2.4
20/06/75	971	11:15	KINEGO Joe	JACKS Roger	HABU	2.4
21/06/75	961	09:30	JOERSZ Al	MORGAN George	D8	1.7
24/06/75	963	09:30	KINEGO Joe	JACKS Roger	HABU	3.2
24/06/75	961	13:30	WILSON Jim	DOUGLASS Brure	D9	2.5
25/06/75	971	10:15	JOERSZ Al	MORGAN George	D9	1.3
27/06/75	961	12:27	JOERSZ Al	MORGAN George	D9	2.2
30/06/75	971		MURPHY Jay	BILLINGSLEY John	D4	
01/07/75	963	10:15	MURPHY Jay	BILLINGSLEY John	D3	2.3
02/07/75	961	09:00	WILSON Jim	DOUGLASS Bruce	D4	2.3
02/07/75	971	13:03	JOERSZ Jim	MORGAN George	HABU	3.6
03/07/75	971	11:51	WILSON Jim	DOUGLASS Bruce	HABU	3.5
07/07/75	963		MURPHY Jay	BILLINGSLEY John	D9	
07/07/75	963	11:30	MURPHY Jay	BILLINGSLEY John	D9	1.3
09/07/75	961	10:15	MURPHY Jay	BILLINGSLEY John	D9	2.9
11/07/75	971	10:00	WILSON Jim	DOUGLASS Bruce	HABU	3.7
11/07/75	963	12:33	JOERSZ Al	MORGAN George	K9	2.7
14/07/75	961	12:49	MURPHY Jay	BILLINGSLEY John	D8	1.7
16/07/75	961	11:59	WILSON Jim	DOUGLASS Bruce	D9	2.7
17/07/75	971	13:00	MURPHY Jay	BILLINGSLEY John	HABU	2.2
18/07/75	971	13:37	JOERSZ Al	MORGAN George	D9	2.4
19/07/75	971	09:15	JOERSZ Al	MORGAN George	HABU	3.5
21/07/75	971	09:26	MURPHY Jay	BILLINGSLEY John	D8	3.8
22/07/75	961	10:18	WILSON Jim	DOUGLASS Bruce	D8	2.5
23/07/75	961	10:00	JOERSZ Al	MORGAN George	D8	4.1
24/07/75	963		MURPHY Jay	BILLINGSLEY John	HABU	
25/07/75	963		MURPHY Jay	BILLINGSLEY John	D1	
25/07/75	963	13:00	MURPHY Jay	BILLINGSLEY John	D3	1
28/07/75	961	10:10	MURPHY Jay	BILLINGSLEY John	HABU	4.2
30/07/75	961	11:20	HELT Bob	ELLIOTT Larry	HABU	3.6
31/07/75	963	08:35	HELT Bob	ELLIOTT Larry	HABU	4.3
01/08/75	961	11:15	SULLIVAN Jim	GERSTEN Mark	D4	2.4
04/08/75	963	09:30	SULLIVAN Jim	GERSTEN Mark	HABU	1.4
08/08/75	961	11:14	SULLIVAN Jim	GERSTEN Mark	HABU	3.5
13/08/75	971	12:51	ROSENBERG Maury	BULLUCH Don	D10	2.2
14/08/75	963	12:00	HELT Bob	ELLIOTT Larry	D10	2.4
15/08/75	963	09:30	HELT Bob	ELLIOTT Larry	HABU	3.8
15/08/75	971	12:09	SULLIVAN Jim	GERSTEN Mark	D10	2.1
22/08/75	961		ROSENBERG Maury	BULLUCH Don	D10	
22/08/75	961	14:20	SULLIVAN Jim	GERSTEN Mark	D4	2.4
24/08/75	971		SULLIVAN Jim	GERSTEN Mark	HABU	
25/08/75	963	10:10	SULLIVAN Jim	GERSTEN Mark	HABU	2.1
26/08/75	963	10:30	SULLIVAN Jim	GERSTEN Mark	HABU	3.6
26/08/75	961	11:15	ROSENBERG Maury	BULLUCH Don	D10	2.2
27/08/75	971	11:18	CHRINO Al	LIEBMAN Bruce	HABU	3.8
28/08/75	961	10:30	SULLIVAN Jim	GERSTEN Mark	D10	2.2
29/08/75	971		SULLIVAN Jim	GERSTEN Mark	HABU	
29/08/75	961	14:11	CIRINO Al	LIEBMAN Bruce	HABU	3.6
02/09/75	961	10:00	ROSENBERG Maury	BULLUCH Don	D8	2.6
03/09/75	961	10:15	SULLIVAN Jim	GERSTEN Mark	D4	2.5
04/09/75	971	09:15	CIRINO Al	LIEBMAN Bruce	D8	4.2
05/09/75	963		ROSENBERG Maury	BULLUCH Don	D10	
05/09/75	963	16:01	ROSENBERG Maury	BULLUCH Don	D10	2.3

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
08/09/75	963		BLEDSOE Pat	BLACKWELL Reggie	D10	
08/09/75	961	09:50	ROSENBERG Maury	BULLUCH Don	HABU	1.5
09/09/75	963	10:00	BELDSOE Pat	BLACKWELL Reggie	D8	4
09/09/75	971	10:45	CIRINO Al	LIEBMAN Bruce	D3	2.6
10/09/75	963	10:28	ROSENBERG Maury	BULLUCH Don	D8	1.8
11/09/75	971	10:00	BLEDSOE Pat	BLACKWELL Reggie	D8	1.4
15/09/75	961	10:15	ROSENBERG Maury	BULLUCH Don	D8	4.2
16/09/75	971	14:42	CIRINO Al	LIEBMAN Bruce	HABU	3.5
17/09/75	961	10:30	BLEDSOE Pat	BLACKWELL Reggie	D8	4.1
19/09/75	961		CIRINO Al	LIEBMAN Bruce	D8	
22/09/75	971	10:15	BLEDSOE Pat	BLACKWELL Reggie	HABU	4.9
22/09/75	961	12:30	GRAHAM Rich	EMMONS Don	D5	3.6
24/09/75	961	11:15	CIRINO Al	LIEBMAN Bruce	D8	2.5
26/09/75	961		GRAHAM Rich	EMMONS Don	D8	
26/09/75	961		CIRINO Al	LIEBMAN Bruce	D5	
29/09/75	961	14:47	CIRINO Al	LIEBMAN Bruce	D8	2.6
30/09/75	971	11:00	GRAHAM Rich	EMMONS Don	HABU	3.6
03/10/75	961	11:00	BLEDSOE Pat	BLACKWELL Reggie	D8	2.8
06/10/75	971		BLEDSOE Pat	BLACKWELL Reggie	HABU	
07/10/75	971	09:00	KINIGO Joe	JACKS Roger	D11	5.6
09/10/75	961	10:10	BLEDSOE Pat	BLACKWELL Reggie	HABU	4.9
10/10/75	971	09:38	GRAHAM Rich	EMMONS Don	D11	5.7
13/10/75	971	10:07	GRAHAM Rich	EMMONS Don	HABU	3.5
17/10/75	961	11:15	KINEGO Joe	JACKS Rogger	HABU	1.9
22/10/75	963		RANSOM Lee	PAYNE Al	D8	
23/10/75	963	10:15	RANSOM Lee	PAYNE Al	D8	4.1
28/10/75	971	10:15	GRAHAM Rich	EMMONS Don	D11	2.1
29/10/75	963	12:30	RANSOM Lee	PAYNE Al	HABU	3.6
30/10/75	961	11:00	KINEGO Joe	JACKS Rogger	HABU	2.6
31/10/75	963	11:00	KINEGO Joe	JACKS Rogger	HABU	1
31/10/75	961	12:15	RANSOM Lee	PAYNE Al	HABU	3.5
03/11/75	971	10:14	WILSON Jim	DOUGLASS Bruce	D8	4.1
05/11/75	961	11:10	WILSON Jim	DOUGLASS Bruce	HABU	3.8
06/11/75	963	10:15	KINEGO Joe	JACKS Rogger	D8	4.2
07/11/75	961		RANSOM Lee	PAYNE Al	D8	
12/11/75	971	11:00	KINEGO Joe	JACKS Rogger	HABU	3.7
14/11/75	963	10:15	RANSOM Lee	PAYNE Al	D4	2.5
17/11/75	971	12:50	WILSON Jim	DOUGLASS Bruce	HABU	3.7
18/11/75	963	12:00	MURPHY Jay	BILLINGSLEY John	HABU	3.8
19/11/75	971		RANSOM Lee	PAYNE Al	D8	
21/11/75	971	10:17	RANSOM Lee	PAYNE Al	D8	3.8
24/11/75	963	10:15	WILSON Jim	DOUGLASS Bruce	D4	2.6
26/11/75	971	10:15	RANSOM Lee	PAYNE Al	D8	3.9
27/11/75	963	12:15	MURPHY Jim	BILLINGSLEY John	HABU	1.9
01/12/75	963	09:31	JOERSZ Al	MORGAN George	D4	2.5
04/12/75	963	10:00	WILSON Jim	DOUGLASS Bruce	HABU	2.6
05/12/75	963	10:15	MURPHY Jay	BILLINGSLEY John	D8	4.1
08/12/75	971	10:16	JOERSZ Al	MORGAN George	D8	4.3
09/12/75	963	11:00	JOERSZ Al	MORGAN George	HABU	3.6
10/12/75	971	10:15	WILSON Jim	DOUGLASS Bruce	D4	2.7
12/12/75	963	11:00	MURPHY Jay	BILLINGSLEY John	HABU	5
15/12/75	971	09:10	JOERSZ Al	MORGAN George	HABU	0.7
16/12/75	963	10:30	JOERSZ Al	MORGAN George	HABU	3.6
16/12/75	971	12:05	ALISON Tom	VIDA Joe (J.T.)	D4	2.7
18/12/75	963	10:00	ALISON Tom	VIDA Joe	HABU	3.6
20/12/75	963	07:00	MURPHY Jay	BILLINGSLEY John	HABU	3.8
22/12/75	971	10:50	ALISON Tom	VIDA Joe	HABU	4.9
29/12/75	963	10:04	JOERSZ Al	MORGAN George	D4	2.6
30/12/75	971	09:30	ROSENBERG Maury	BULLUCH Don	HABU	3.6
31/12/75	963	10:05	ALISON Tom	VIDA Joe	D4	2.5
05/01/76	971	10:50	JOERSZ Al	MORGAN George	HABU	4.9
08/01/76	971	09:30	ALISON Tom	VIDA Joe	HABU	3.7
10/01/76	963	10:14	ROSENBERG Maury	BULLUCH Don	D4	2.5
12/01/76	963	10:15	ROSENBERG Maury	BULLUCH Don	HABU	3.6
14/01/76	961	14:04	ALISON Tom	VIDA Joe	D4	2.6
17/01/76	963	12:15	HELT Bob	ELLIOTT Larry	HABU	1.1
20/01/76	971	11:42	ALISON Tom	VIDA Joe	HABU	3.5
21/01/76	961	10:03	ROSENBURG Maury	BULLUCH Don	D8	4.1
23/01/76	961	11:30	HELT Bob	ELLIOTT Larry	HABU	3.7
23/01/76	961	13:05	ROSENBURG Maury	BULLUCH Don	D7	1.7
24/01/76	971	10:30	ROSENBURG Marry	BULLUCH Don	HABU	3.7
27/01/76	961	11:00	BLEDSOE Pat	FULLER John	HABU	3.6
29/01/76	963	12:40	HELT Bob	ELLIOTT Larry	HABU	4.3
02/02/76	961	10:15	ROSENBERG Maury	BULLUCH Don	D4	2.7
06/02/76	963	10:02	BLEDSOE Pat	FULLER John	HABU	4.8
07/02/76	961	10:31	HELT Bob	ELLIOTT Larry	HABU	3.8
10/02/76	963	11:30	CIRINO Al	LIEBMAN Bruce	HABU	2.4
11/02/76	963	10:15	HELT Bob	ELLIOTT Larry	D4	2.6
12/02/76	963		BLEDSOE Pat	FULLER John	HABU	
13/02/76	963	11:22	BLEDSOE Pat	FULLER John	HABU	3.9
16/02/76	971	10:56	CIRINO Al	LIEDMAN Bruce	D8	4.5
18/02/76	961	11:50	HELT Bob	ELLIOTT Larry	HABU	3.7
19/02/76	963	10:20	BLEDSOE Pat	FULLER John	D4	2.4

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
20/02/76	971	09:10	CIRINO Al	LIEBMAN Bruce	HABU	1.3
20/02/76	961	10:10	BLEDSOE Pat	FULLER John	HABU	2
23/02/76	961	10:17	GRAHAM Rich	EMMONS Don	D8	4.1
24/02/76	971		CIRINO Al	LIEBMAN Bruce	HABU	
24/02/76	961	11:30	GRAHAM Rich	EMMONS Don	HABU	3.6
26/02/76	961	10:48	CIRINO Al	LIEBMAN Bruce	D4	2.6
27/02/76	963	11:05	BLEDSOE Pat	EMMONS Don	D4	2.7
27/02/76	961	12:30	CIRINO Al	LIEBMAN Bruce	HABU	3.7
01/03/76	971		GRAHAM Rich	EMMONS Don	D4	
02/03/76	961	10:30	BLEDSOE Pat	FULLER John	HABU	2.7
03/03/76	971	10:15	GRAHAM Rich	EMMONS Don	D4	2.6
04/03/76	971	10:30	GRAHAM Rich	EMMONS Don	HABU	3.5
08/03/76	971	10:15	CIRINO Al	LIEBMAN Bruce	D8	4
09/03/76	971	10:00	CIRINO Al	LIEBMAN Bruce	HABU	2.4
10/03/76	961	10:15	RANSOM Lee	PAYNE Al	D4	2.6
12/03/76	961	11:00	GRAHAM Rich	EMMONS Don	SPECIAL-CAPSTAN DRAGON SNAPPER	1.9
15/03/76	971	10:18	CIRINO Al	LIEBMAN Bruce	D4	2.6
17/03/76	961	10:50	GRAHAM Rich	EMMONS Don	HABU	3.6
19/03/76	971		RANSOM Lee	PAYNE Al	D4	
20/03/76	961	09:30	RANSOM Lee	PAYNE Al	HABU	4.8
22/03/76	971	10:30	MURPHY Jay	BILLINGSLEY John	D4	2
23/03/76	963		GRAHAM Rich	EMMONS Don	D8	
24/03/76	961	09:45	GRAHAM Rich	EMMONS Don	HABU	3.7
25/03/76	963		RANSOM Lee	PAYNE Al	D8	
25/03/76	963		RANSOM Lee	PAYNE Al	D8	
26/03/76	963	11:47	RANSOM Lee	PAYNE Al	D4	2.4
26/03/76	971	10:17	MURPHY Jay	BILLINGSLEY John	D4	2.3
29/03/76	961	10:58	MURPHY Jay	BILLINGSLEY John	HABU	3.6
30/03/76	963	10:19	GRAHAM Rich	EMMONS Don	D4	2.5
02/04/76	971	14:05	RANSOM Lee	PAYNE Al	D4	1.7
05/04/76	961	10:22	KINEGO Joe	JACKS Roger	D4	2.4
06/04/76	961	12:08	RANSOM Lee	PAYNE Al	HABU	2.1
07/04/76	963	10:15	WILSON Jim	DOUGLASS Bruce	D8	4.3
08/04/76	971	13:05	WILSON Jim	DOUGLASS Bruce	HABU	2
10/04/76	971	11:30	KINEGO Joe	JACKS Roger	HABU	2.3
12/04/76	961	11:46	RANSOM Lee	PAYNE Al	D8	2.3
13/04/76	963	10:16	WILSON Jim	DOUGLASS Bruce	D4	2.6
14/04/76	971	10:48	KINEGO Joe	JACKS Roger	D8	4.2
19/04/76	963	10:20	JOEHSZ Al	MORGAN George	D4	2.5
20/04/76	971	10:22	WILSON Jim	DOUGLASS Bruce	HABU	3.7
22/04/76	963	10:25	KINEGO Joe	JACKS Roger	D4	2.5
23/04/76	971	09:30	KINEGO Joe	JACKS Roger	HABU	3.5
26/04/76	971	10:00	JOERSZ Al	MORGAN George	HABU	3.5
27/04/76	961	10:42	WILSON Jim	DOUGLASS Bruce	D8	4.2
28/04/76	963		KINEGO Joe	JACKS Roger	D4	
28/04/76	963	11:20	KINEGO Joe	JACKS Roger	D4	2.5
30/04/76	961	11:15	JOERSZ Al	MORGAN George	D4	2.5
03/05/76	971	10:31	WILSON Jim	DOUGLASS Bruce	D4	2.5
04/05/76	961	12:30	WILSON Jim	DOUGLASS Bruce	HAHU	4
06/05/76	963	09:30	KINEGO Joe	JACKS Roger	HABU	0.8
06/05/76	971	10:37	JOERSZ Al	MORGAN George	HABU	4.6
08/05/76	961	09:40	KINEGO Joe	JACKS Roger	HABU	4.9
10/05/76	971	10:30	WILSON Jim	DOUGLASS Bruce	D4	2.6
11/05/76	961	10:00	JOEKSZ Al	MORGAN George	D4	2.3
12/05/76	963	10:15	KINEGO Joe	JACKS Roger	D4	2.4
17/05/76	971	10:15	MURPHY Jay	BILLINGSLEY John	D4	1.5
18/05/76	963	13:47	WILSON Jim	DOUGLASS Bruce	HABU	3.6
21/05/76	963	10:15	JOERSZ Al	MORGAN George	HABU	1
24/05/76	963	10:15	JOERSZ Al	MORGAN George	HABU	1.1
25/05/76	961	10:01	WILSON Jim	DOUGLASS Bruce	D2	2.4
26/05/76	971	09:45	MURPHY Jay	BILLINGSLEY John	HABU	3.9
28/05/76	971		MURPHY Jay	BILLINGSLEY John	HABU	
28/05/76	971	14:55	MURPHY Jay	BILLINGSLEY John	HABU	2.2
01/06/76	963	10:17	ALISON Tom	VIDA Joe	D4	2.3
02/06/76	961	11:15	ROSENBERG Maury	BULLUCH Don	D4	2.2
03/06/76	971	10:15	ALISON Tom	VIDA Joe	HABU	3.8
07/06/76	963	10:27	MURPHY Jay	BILLINGSLEY John	D4	2.3
08/06/76	961	11:05	ROSENBERG Maury	BULLUCH Don	HAHU	2.1
09/06/76	971	10:17	ALISON Tom	VIDA Joe	D2	2.3
10/06/76	961	13:00	ALISON Tom	VIDA Joe	HABU	2.2
14/06/76	963	10:15	BLEDSOE Pat	FULLER John	D2	2.2
15/06/76	971	11:30	ROSENBURG Maury	BULLUCH Don	HABU	3.7
18/06/76	963	10:39	ALISON Tom	VIDA Joe	D4	2.3
21/06/76	963	12:00	BLEDSOE Pat	FULLER John	D4	2.5
22/06/76	971	09:30	ALISON Tom	VIDA Joe	HABU	3.6
23/06/76	963	10:15	ROSENBERG Maury	BULLUCH Don	D4	2.6
26/06/76	971		BLEDSOE Pat	FULLER John	HABU	
26/06/76	963	12:57	ROSENBERG Maury	BULLUCH Don	HABU	3.6
27/06/76	971	13:00	BLEDSOE Pat	FULLER John	HABU	2.4
28/06/76	963		ALISON Tom	VIDA Joe	D11	
29/06/76	963	12:15	ALISON Tom	VIDA Joe	HABU	3.9

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
03/07/76	961	11:17	ROSENBERG Maury	BULLUCH Don	D4	2.4
06/07/76	963	11:48	BLEDSOE Pat	FULLER John	D4	2.4
07/07/76	971	10:15	ROSENBERG Maury	BULLUCH Don	HABU	3.6
07/07/76	961	15:43	ALISON Tom	VIDA Joe	D4	2.2
08/07/76	963	12:00	BLEDSOE Pat	FULLER John	HABU	2.2
12/07/76	961	13:10	ALISON Tom	VIDA Joe	HABU	2.7
13/07/76	979	04:00	GRAHAM Rich	EMMONS Don	FERRY IN	5.3
13/07/76	963	10:23	BLEDSOE Pat	FULLER John	D4	2.2
14/07/76	971	06:00	ROSENBERG Maury	BULLUCH Don	FERRY OUT	
14/07/76	979	13:38	BLEDSOE Pat	FULLER John	HABU	2.3
15/07/76	972	04:00	MURPHY Jay	BILLINGSLEY John	FERRY IN	5.1
16/07/76	963	06:00	ALISON Tom	VIDA Joe	FERRY OUT	
16/07/76	961	06:42	MURPHY Jay	BILLINGSLEY John	D1	1.2
20/07/76	976	04:00	CIRINO Al	LIEBMAN Bruce	FERRY IN	5.2
20/07/76	979	13:30	GRAHAM Rich	EMMONS Don	HABU	3.7
21/07/76	961	06:42	MURPHY Jay	BILLINGSLEY John	FERRY OUT	
21/07/76	972	10:15	BLEDSOE Pat	FULLER John	D4	2.3
23/07/76	976	14:05	CIRINO Al	LIEBMAN Bruce	HABU	3.6
26/07/76	976	13:15	GRAHAM Rich	EMMONS Don	HABU	3.8
27/07/76	979	10:17	KINEGO Joe	JACKS Roger	D4	2.5
29/07/76	972	10:45	CIRINO Al	LIEBMAN Bruce	D4	2.5
30/07/76	976		KINEGO Joe	JACKS Roger	HABU	3
02/08/76	976	10:21	GRAHAM Rich	EMMONS Don	D4	2.5
03/08/76	972	10:15	CIRINO Al	LIEBMAN Bruce	D4	1.9
05/08/76	976	11:50	KINEGO Joe	JACKS Roger	D4	2.4
06/08/76	979	11:45	CIRINO Al	LIEBMAN Bruce	HABU	3.9
11/08/76	979	11:03	GRAHAM Rich	EMMONS Don	HABU	3.6
12/08/76	972	10:19	KINEGO Joe	JACKS Roger	D4	2.5
13/08/76	976	10:15	CIRINO Al	LIEBMAN Bruce	D8	3.4
14/08/76	972	09:50	KINEGO Joe	JACKS Roger	HABU	3.7
16/08/76	979	10:18	CIRINO Al	LIEBMAN Bruce	D4	2.3
18/08/76	976	11:00	GRAHAM Rich	EMMONS Don	D1	0.9
19/08/76	972	14:15	KINEGO Joe	JACKS Roger	HABU	2.4
21/08/76	976	09:01	MURPHY Jay	BILLINGSLEY John	HABU	3.9
23/08/76	979	08:00	GILMORE Bill	PAYNE Al	HABU	4
26/08/76	976	13:00	KINEGO Joe	JACKS Roger	HABU	2.1
28/08/76	979	10:00	MURPHY Jay	BILLINGSLEY John	HABU	3.3
31/08/76	976	10:00	MURPHY Jay	BILLINGSLEY John	HABU	2.2
03/09/76	976	10:30	GILMORE Bill	PAYNE Al	HABU	3.9
04/09/76	979	09:30	JOERSZ AL	MORGAN George	HABU	3.5
07/09/76	972		GILMORE Bill	PAYNE Al	D8	
07/09/76	976	10:00	MURPHY Jay	BILLINGSLEY John	HABU	4.2
11/09/76	979	10:31	GILMORE Bill	PAYNE Al	D4	2.3
13/09/76	976	10:30	GILMORE Bill	PAYNE Al	HABU	2.4
15/09/76	979	10:46	JOERSZ Al	MORGAN George	D3	2.3
16/09/76	972	11:01	GILMORE Bill	PAYNE Al	D8	4.1
17/09/76	979	13:30	JOERSZ Al	MORGAN George	HABU	3.5
20/09/76	976	10:30	ALISON Tom	VIDA Joe	D8	4
21/09/76	976	11:02	GILMORE Bill	PAYNE Al	D4	2.4
22/09/76	972	11:00	GILMORE Bill	PAYNE Al	HABU	5.3
23/09/76	976	09:30	ALISON Tom	VIDA Joe	HABU	2.2
24/09/76	972	10:13	JORESZ Al	MORGAN George	D8	4.1
27/09/76	979	10:25	GILMORE Bill	PAYNE Al	D5	3.7
28/09/76	972	11:16	ALISON Tom	VIDA Joe	D5	3.6
29/09/76	979	11:15	JOERSZ Al	MORGAN George	HABU	2.4
01/10/76	972	11:01	ALISON Tom	VIDA Joe	D8	4
04/10/76	972	10:14	ROSENBERG Maury	BULLUCH Don	D8	4
06/10/76	976	09:30	ALISON Tom	VIDA Joe	HABU	3.6
07/10/76	972	11:10	JOERSZ Al	MORGAN George	D8	3.7
12/10/76	976	10:00	JOERSZ Al	MORGAN George	HABU	3.5
13/10/76	972	10:01	ROSENBERG Maury	BULLUCH Don	D8	4.1
14/10/76	976	10:30	ROSENBERG Maury	BULLUCH Don	HABU	5.2
15/10/76	972	11:00	ALISON Tom	VIDA Joe	HABU	3.7
18/10/76	972	14:25	BLEDSOE Pat	FUILER John	D12	2.4
19/10/76	976	10:00	ALISON Tom	VIDA Joe	D3	2.2
21/10/76	972	10:30	ROSENBERG Maury	BULLUCH Don	D8	1.6
22/10/76	976	11:31	BLEDSOE Pat	FULLER John	HABU	2.5
25/10/76	979	10:00	ALISON Tom	VIDA Joe	D8	4.1
26/10/76	972	14:00	ROSENBERG Maury	BULLUCH Don	HABU	4
27/10/76	979		BLEDSOE Pat	FULLUCH John	D8	
28/10/76	979	10:34	BLEDSOE Pat	FULLER John	D3	1.6
29/10/76	972	14:30	ALISON Tom	VIDA Joe	HABU	3.8
30/10/76	976	12:00	ROSENBERG Maury	BULLUCH Don	SAROOI	4.1
02/11/76	972	11:10	BLEDSOE Pat	FULLER John	D3	2.6
04/11/76	972	08:20	BLEDSOE Pat	FULLER John	HABU	4
05/11/76	976	10:55	ALISON Tom	VIDA Joe	D12	1.8
08/11/76	979		ROSENBERG Maury	BULLUCH Don	D8	
12/11/76	979	11:15	BLEDSOE Pat	FULLER John	D7	2.3
13/11/76	972	09:45	GRAHAM Rich	EMMONS Don	D3	2.3
15/11/76	972	11:00	BLEDSOE Pat	FULLER John	HABU	5.3
16/11/76	979	09:25	CIRINO Al	LIEBMAN Bruce	D7	2.5
18/11/76	979	10:46	CIRINO Al	LIEBMAN Bruce	HABU	3.9
19/11/76	976	10:07	GRAHAM Rich	EMMONS Don	D12	2.4

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
20/11/76	979		GRAHAM Rich	EMMONS Don	HABU	
22/11/76	976	13:00	GRAHAM Rich	EMMONS Don	HABU	3.6
23/11/76	979	11:30	BLEDSOE Pat	FULLER John	HABU	5.5
27/11/76	976	09:30	CIRINO Al	LIEBMAN Bruce	HABU	3.6
29/11/76	979	10:50	GRAHAM Rich	EMMONS Don	HABU	3.9
30/11/76	972	11:10	KINEGO Joe	JACKS Roger	HABU	2.1
03/12/76	972	12:00	CIRINO Al	LIEBMAN Bruce	HABU	3.6
07/12/76	979	13:15	GRAHAM Rich	EMMONS Don	HABU	3.7
11/12/76	972	10:30	KINEGO Joe	JACKS Roger	HABU	2.3
13/12/76	979	10:20	CROWDER Bob	MORGAN John	D3	2.5
15/12/76	972	11:15	GRAHAM Rich	EMMONS Don	HABU	3.5
17/12/76	976		KINEGO Joe	JACKS Roger	D8	
20/12/76	979	13:45	GRAHAM Rich	EMMONS Don	HABU	3.6
21/12/76	976		CROWDER Bob	MORGAN John	D8	
23/12/76	976	10:08	KINEGO Joe	JACKS Roger	D8	4.2
24/12/76	972	10:12	CROWDER Bob	MORGAN John	HABU	3.9
28/12/76	976	10:34	CROWDER Bob	MORGAN John	D8	4.3
29/12/76	979	12:08	KINEGO Joe	JACKS Roger	HABU	2.8
30/12/76	972	10:10	CROWDER Bob	MORGAN John	D5	3.7
03/01/77	976	11:00	KINEGO Joe	JACKS Roger	D4	2.7
05/01/77	979	06:55	CROWDER Bob	MORGAN John	HABU	3.5
07/01/77	972	11:08	MURPHY Jay	BILLINGSLEY John	D12	2.6
10/01/77	979	09:58	JOERSZ Al	PAYNE Al	D8	2.2
11/01/77	976	11:00	CROWDER Bob	MORGAN John	HABU	3.6
12/01/77	972	10:41	MURPHY Jay	BILLINGSLEY John	D3	2.4
13/01/77	976	10:40	JOERSZ Al	PAYNE Al	HABU	3.5
14/01/77	979	10:00	CROWDER Bob	MORGAN John	D3	6.1
15/01/77	972	09:55	MURPHY Jay	BILLINGSLEY John	HABU	3.7
17/01/77	972	12:30	CROWDER Bob	MORGAN John	HABU	4
20/01/77	976	11:00	MURPHY Jay	BILLINGSLEY John	D8	2.3
21/01/77	979	13:15	JOERSZ Al	PAYNE Al	HABU	4
24/01/77	972	10:59	ROSENBERG Maury	BULLUCH Don	D3	2.3
26/01/77	979	09:30	ROSENBERG Maury	BULLUCH Don	HABU	3.1
27/01/77	976	13:50	JOERSZ Al	PAYNE Al	HABU	3.8
31/01/77	979	10:03	MURPHY Jay	BILLINGSLEY John	D8	4.2
04/02/77	972	09:30	RUSENBERG Maury	BULLUCH Don	D2	2.4
05/02/77	976	10:00	MURPHY Jay	BILLINGSLEY John	HABU	1.5
07/02/77	979	09:30	JOERSZ Al	PAYNE Al	D4	2.6
08/02/77	976	11:02	MURPHY Jay	BILLINGSLEY John	HABU	4.1
10/02/77	972		ROSENBERG Maury	BULLUCH Don	HABU	
14/02/77	976	14:17	ROSENBERG Maury	BULLUCH Don	HABU	1.5
16/02/77	976	11:00	JOERSZ Al	PAYNE Al	HABU	2.3
17/02/77	976	09:30	ROSENBERG Maury	BULLUCH Don	HABU	2.4
18/02/77	979	10:00	CIRINO Al	LIEBMAN Bruce	P2	2.5
19/02/77	976	09:10	ROSENBERG Maury	BULLUCH Don	HABU	4.2
21/02/77	979	10:15	ALISON Tom	VIDA Joe	HABU	4
22/02/77	976	13:15	CIRINO Al	LIEBMAN Bruce	HABU	2.3
24/02/77	979	10:00	ROSENBERG Maury	BULLUCH Don	HABU	3.7
26/02/77	976	10:30	ALISON Tom	VIDA Joe	HABU	4
28/02/77	979	10:00	ROSENBERG Maury	BULLUCH Don	P2	2.5
01/03/77	976	09:10	ALISON Tom	VIDA Joe	P2	2.4
03/03/77	979	12:00	ALISON Tom	VIDA Joe	HABU	3.6
07/03/77	976	11:00	CIRINO Al	LIEBMAN Bruce	HABU	2.2
08/03/77	972	10:37	BLEDSOE Pat	FULLER John	P8	3.6
09/03/77	979	09:52	BLEDSOE Pat	FULLER John	HABU	4.1
10/03/77	972	09:45	CIRINO Al	LIEUMAN Bruce	P8	4.1
11/03/77	976	11:03	ALISON Tom	VIDA Joe	P4	3.8
15/03/77	979	12:22	CIRINO Al	LIEBMAN Bruce	HABU	2.7
17/03/77	976	10:30	BLEDSOE Pat	FULLER John	P2	2.3
18/03/77	979	09:30	ALISON Tom	VIDA Joe	HABU	4.1
21/03/77	972	10:20	CARPENTER Buzz	MURPHY John	P8	4.2
22/03/77	976	10:15	BLEDSOE Pat	FULLER John	D8	1.8
23/03/77	979	11:30	BLEDSOE Pat	FULLER John	HABU	4.1
24/03/77	972	13:02	ALISON Tom	VIDA Joe	P8	4.2
25/03/77	976	10:30	CARPENTER Buzz	MURPHY John	D8	4.1
28/03/77	979	11:36	CARPENTER Buzz	MURPHY John	HABU	4
01/04/77	976	10:30	BLEDSOE Pat	FULLER John	P8	3.8
04/04/77	972	11:00	GRAHAM Rich	EMMONS Don	P8	4.1
05/04/77	979	09:30	BLEDSOE Pat	FULLER John	HABU	4.2
06/04/77	972	10:30	CARPENTER Buzz	MURPHY John	P8	3.8
08/04/77	979	13:00	CARPENTER Buzz	MURPHY John	HABU	4.2
11/04/77	976	10:33	BLEDSOE Pat	FULLER John	P8	4.3
12/04/77	972	11:00	GRAHAM Rich	EMMONS Don	P8	3.6
14/04/77	976	10:16	CARPENTER Buzz	MURPHY John	D8	3.8
16/04/77	972	09:05	GRAHAM Rich	EMMONS Don	HABU	4
19/04/77	972	13:00	CARPENTER Buzz	MURPHY John	HABU	2.4
19/04/77	976	09:30	KINEGO Joe	JACKS Roger	HABU	1.4
22/04/77	972	10:06	GRAHAM Rich	EMMONS Don	HABU	2.6
22/04/77	976		KINCGO Joe	JACKS Roger	HABU	
22/04/77	972		GRAHAM Rich	EMMONS Don	HABU	
25/04/77	976	11:00	KINEGO Joe	JACKS Roger	HABU	2.5
26/04/77	972	12:00	GRAHAM Rich	EMMONS Don	HABU	2.5
29/04/77	976	09:20	KINEGO Joe	JACKS Roger	HABU	3.8

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
02/05/77	979	10:12	CROWDER Bob	MORGAN John	D8	4
03/05/77	972	10:13	GRAHAM Rich	EMMONS Don	P8	3.9
04/05/77	976		GRAHAM Rich	EMMONS Don	HABU	
06/05/77	979	09:20	GRAHAM Rich	EMMONS Don	HABU	4.1
07/05/77	972	11:00	CROWDER Bob	MORGAN John	HABU	3.5
10/05/77	976	09:45	KINEGO Joe	JACKS Roger	HABU	3.6
12/05/77	976	14:15	CROWDER Bob	MORGAN John	HABU	4.3
13/05/77	972	10:09	KINEGO Joe	JACKS Roger	FERRY TO GUAM STATIC DISPLAY	2.5
15/05/77	972	11:00	CROWDER Bob	MORGAN John	RTB FERRY	3
17/05/77	979	10:30	MURPHY Jay	BILLINGSLEY John	P8	1.2
18/05/77	976	10:15	CROWDER Bob	MORGAN John	D8	4.1
19/05/77	972	13:07	KINEGO Joe	JACKS Roger	P2	2.5
21/05/77	976	14:00	KINEGO Joe	JACKS Roger	HABU	3.9
23/05/77	972		MURPHY Jay	BILLINGSLEY John	D8	
23/05/77	972	11:45	MURPHY Jay	BILLINGSLEY John	P8	4.1
24/05/77	979	10:15	CROWDER Bob	MORGAN John	P8	4
26/05/77	976	12:11	MURPHY Jay	BILLINGSLEY John	P2	2.3
27/05/77	979	15:00	MURPHY Jay	BILLINGSLEY John	HABU	2.2
31/05/77	979	14:00	JOERSZ Al	BULLUCH Don	HABU	3.5
01/06/77	976	10:45	CROWDER Bob	MORGAN John	D8	3.9
03/06/77	972	10:30	MURPHY Jay	BILLINGSLEY John	D8	3.7
04/06/77	979		CROWDER Bob	MORGAN John	HABU	
04/06/77	979	11:05	CROWDER Bob	MORGAN John	HABU	1.8
06/06/77	972	11:00	MURPHY Jay	BILLINGSLEY John	HABU	2.4
07/06/77	979		CROWDER Bob	MORGAN John	HABU	
07/06/77	979	12:49	CROWDER Bob	MORGAN John	HABU	4
10/06/77	972	11:04	JOERSZ Al	BULLUCH Don	P7	2.1
14/06/77	979	09:20	JOERSZ Al	BULLUCH Don	HABU	3.8
15/06/77	972	10:15	ROSENBERG Maury	PAYNE Al	P7	2.3
17/06/77	979	10:05	MURPHY Jay	BILLINGSLEY John	HABU	2.6
23/06/77	972	11:00	ROSENBERG Maury	PAYNE Al	P13	2.5
24/06/77	979	13:13	ROSENBERG Maury	PAYNE Al	HABU	4.1
25/06/77	972	09:30	CIRINO Al	LIEDMAN Bruce	HABU	4.1
27/06/77	979	13:39	ALISON Tom	VIDA Joe	HABU	2.5
27/06/77	976	12:44	CIRINO Al	LIEBMAN Bruce	P7	2.5
27/06/77	979		ALISON Tom	VIDA Joe	HABU	
30/06/77	976		ROSENBERG Maury	PAYNE Al	HABU	
30/06/77	976	12:18	ROSENBERG Maury	PAYNE Al	HABU	3.9
01/07/77	976	10:51	ALISON Tom	VIDA Joe	D13	2.5
05/07/77	976	10:00	CIRINO Al	LIEBMAN Bruce	P8	4
07/07/77	979	11:44	ROSENBERG Maury	PAYNE Al	D8	3.8
07/07/77	979		ROSENBERG Maury	PAYNE Al	D8	
08/07/77	976	07:00	CIRINO Al	LIEBMAN Bruce	HABU	2.3
11/07/77	976	14:00	ALISON Tom	VIDA Joe	HABU	3.8
12/07/77	979	09:53	ROSENBERG Maury	PAYNE Al	D8	3.3
14/07/77	976	08:00	ALISON Tom	VIDA Joe	HABU	4.1
15/07/77	979	10:00	CIRINO Al	LIEDMAN Bruce	P5	3.7
18/07/77	972		ALISON Tom	VIDA Joe	D7	
19/07/77	979	09:29	ROSENBERG Maury	PAYNE Al	HABU	4.1
19/07/77	972	09:00	ALISON Tom	VIDA Joe	P1	1.1
19/07/77	979		ROSENBERG Maury	PAYNE Al	HABU	
21/07/77	976	10:07	CIRINO Al	LIEBMAN Bruce	P5	2.5
23/07/77	976	09:15	CIRINO Al	LIEBMAN Bruce	HABU	4.3
25/07/77	972	21:20	BLEDSOE Pat	FULLER John	N-D7	2.4
27/07/77	972	13:00	CARPENTER Buzz	MURPHY John	HABU	4.2
28/07/77	976	10:09	CIRINO Al	LIEDMAN Bruce	D7	3.1
31/07/77	976	14:00	BLEDSOE Pat	FULLER John	HABU	2.3
01/08/77	979	10:00	CARPENTER Buzz	MURPHY John	D4	2.5
02/08/77	976	09:33	CIRINO Al	LIEBMAN Bruce	HABU	1
04/08/77	976	14:58	BLEDSOE Pat	FULLER John	HABU	4.2
05/08/77	972	13:07	CARPENTER Buzz	MURPHY John	HABU	2.5
08/08/77	979	08:50	CIRINO Al	FULLER John	P4	3.5
09/08/77	976	06:00	CIRINO Al	LIEBMAN Bruce	H/FERRY OUT	
10/08/77	960	04:00	ROSENBERG Maury	PAYNE Al	FERRY IN / HABU	5.5
11/08/77	972	06:00	BLEDSOE Pat	FULLER John	FERRY OUT	
12/08/77	960	08:45	ROSENBERG Maury	PAYNE Al	D4	2.6
12/08/77	975	04:00	GRAHAM Rich	EMMONS Don	FERRY IN	5
13/08/77	979	06:20	ROSENBERG Maury	PAYNE Al	FERRY OUT	
14/08/77	967	04:00	KINEGO Joe	ELLIOTT Larry	FERRY IN	5.3
15/08/77	967	09:52	CARPENTER Buzz	MURPHY John	HABU	5.4
18/08/77	967	10:18	GRAHAM Rich	EMMONS Don	HABU	1
19/08/77	960	10:49	CARPENTER Buzz	MURPHY John	D4	4.1
23/08/77	960	15:12	CARPENTER Buzz	MURPHY John	HABU	2.1
23/08/77	967		GRAHAM Rich	EMMONS Don	D4	
24/08/77	975	10:00	GRAHAM Rich	EMMONS Don	D4	2.4
25/08/77	975	09:26	KINEGO Joe	ELLIOTT Larry	HABU	2.2
27/08/77	975	12:12	CARPENTER Buzz	MURPHY John	HABU	4.2
29/08/77	967	12:00	KINEGO Joe	ELLOTT Larry	D4	4.4
30/08/77	975	09:15	GRAHAM Rich	EMMONS Don	HABU	3.8
02/09/77	967	10:48	KINEGO Joe	ELLIOTT Larry	HABU	3.8
02/09/77	960	10:48	VETH Jack	KELLER Bill	D7	2.5
07/09/77	960	09:30	GRAHAM Rich	EMMONS Don	HABU	2.4

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
07/09/77	975	10:31	VETH Jack	KELLER Bill	D7	2.4
12/09/77	967	10:21	KINEGO Joe	ELLIOTT Larry	D4	1.4
13/09/77	975	09:10	VETH Jack	KELLER Bill	HABU	3.8
15/09/77	967	11:55	VETH Jack	KELLER Bill	D7	4.1
16/09/77	960	13:00	KINEGO Joe	ELLIOTT Larry	HABU	3.9
19/09/77	960	21:05	VETH Jack	KELLER Bill	N-HABU	4.1
21/09/77	960		CROWDER Bob	MORGAN John	D11	
22/09/77	975	10:20	CROWDER Bob	MORGAN John	HABU	4.1
23/09/77	960	10:03	KINEGO Joe	ELLIOTT Larry	D4	2.5
23/09/77	967	09:53	VETH Jack	KELLER Bill	P13	2.1
26/09/77	960	09:36	CROWDER Bob	MORGEN John	P11	6.3
27/09/77	967	21:30	KINEGO Joe	ELLIOTT Larry	N-HABU	4.3
29/09/77	960	12:18	VETH Jack	KELLER Bill	P11	5.9
03/10/77	975	10:45	VETH Jack	KELLER Bill	HABU	4.1
04/10/77	960	09:30	MURPHY Jay	BILLINGSLEY John	D4	2.5
07/10/77	975	09:12	CROWDER Bob	MORGAN John	HABU	3.9
11/10/77	967	09:15	VETH Jack	KELLER Bill	HABU	3.8
12/10/77	960	06:50	MURPHY Jay	BILLINGSLEY John	D4	2.4
14/10/77	967	09:05	MURPHY Jay	BILLINGSLEY John	HABU	4.2
19/10/77	975	11:15	CROWDER Bob	MORGAN John	HABU	2.3
20/10/77	967	10:00	ROSENBERG Maury	PAYNE Al	D8	4.4
21/10/77	975	10:15	MURPHY Jay	BILLINGSLEY John	D8	4.3
22/10/77	967	10:40	ROSENBERG Maury	PAYNE Al	HABU	4.3
25/10/77	975	18:30	CROWDER Bob	MORGAN John	N-D4	2.5
27/10/77	967	14:00	ROSENBERG Maury	PAYNE Al	HABU	4.2
28/10/77	975	10:00	ALISON Tom	VIDA Joe	D8	3.1
01/11/77	967	10:15	MURPHY Jay	BILLINGSLEY John	HABU	2
03/11/77	967	14:00	MURPHY Jay	BILLINGSLEY John	RTB FERRY	1.8
05/11/77	975	14:33	ALISON Tom	VIDA Joe	HABU	4.3
07/11/77	967	09:58	ROSENBERG Maury	PAYNE Al	D4	2.3
08/11/77	975	10:00	MURPHY Jay	BILLINGSLEY John	D8	2.4
10/11/77	975	09:53	ROSENBERG Maury	PAYNE Al	D4	2.5
11/11/77	967	09:10	ROSENBERG Maury	PAYNE Al	HABU	1.4
14/11/77	960	10:18	CARPENTER Buzz	MURPHY John	D8	3.4
15/11/77	975	11:00	ALISON Tom	VIDA Joe	D8	4.6
16/11/77	967	20:15	ALISON Tom	VIDA Joe	N-HABU	2.5
18/11/77	960		CARPENTER Buzz	MURPHY John	HABU	
21/11/77	967	10:02	ROSENBERG Maury	PAYNE Al	D8	3.9
22/11/77	960		CARPENTER Buzz	MURPHY John	P4	
23/11/77	967	09:15	CARPENTER Buzz	MURPHY John	HABU	3.6
23/11/77	960	14:45	ALISON Tom	VIDA Joe	P2	2.4
25/11/77	960	20:00	ALISON Tom	VIDA Joe	N-HABU	2.3
28/11/77	967	12:48	CARPENTER Buzz	MURPHY John	HABU	4.4
29/11/77	960	10:00	GRAHAM Rich	MURPHY Don	P13	3.2
02/12/77	960	10:40	GRAHAM Rich	MURPHY Don	HABU	3.8
05/12/77	967	12:19	ALISON Tom	VIDA Joe	D8	2.5
06/12/77	960	10:00	ALISON Tom	VIDA Joe	HABU	5.3
08/12/77	967	10:24	CARPENTER Buzz	MURPHY John	D8	3.8
10/12/77	960	11:02	GRAHAM Rich	EMMONS Don	GIANT BARNACLE	1.9
12/12/77	967	11:00	GRONINGER Bill	SOBER Chuck	GIANT BARNACLE	4.1
13/12/77	960	21:00	CARPENTER Buzz	MURPHY John	N-HABU	2.4
15/12/77	975	10:06	GRONINGER Bill	SOBER Chuck	D8	3.2
16/12/77	960	13:15	GRAHAM Rich	EMMONS Don	HABU	4
19/12/77	960	11:15	GRONINGER Bill	SOBER Chuck	HABU	2.3
20/12/77	975	10:14	CARPENTER Buzz	MURPHY John	P4	2.4
22/12/77	960	19:00	GRAHAM Rich	EMMONS Don	N-HABU	2.4
23/12/77	975	13:00	VETH Jack	KELLER Bill	P2	2.3
28/12/77	975	14:45	GRAHAM Rich	EMMONS Don	D8	3.2
28/12/77	975	12:03	GRONINGER Bill	SOBER Chuck	HABU	4
03/01/78	975	13:16	VETH Jack	KELLER Bill	HABU	4.3
06/01/78	967	08:56	VETH Jack	KELLER Bill	D4	1.4
06/01/78	975	08:01	GRONINGER Bill	SOBER Chuck	SPECIAL MISSION	4.4
09/01/78	975	10:06	KINEGO Joe	ELLIOTT LARRY	D8	4.3
10/01/78	967	10:10	GRONINGER Bill	SOBER Chuck	HABU	2.5
11/01/78	960	08:05	VETH Jack	KELLER Bill	D8	4.7
13/01/78	960	10:00	KINEGO Joe	ELLIOTT Larry	D8	5.1
16/01/78	967	13:15	VETH Jack	KELLER Bill	D8	2
17/01/78	960	09:36	GRONINGER Bill	SOBER Chuck	D11	2.7
19/01/77	975	10:00	VETH Jack	KELLER Bill	P2	2.4
20/01/78	967		KINEGO Joe	ELLIOTT Larry	HABU	
20/01/78	967		KINEGO Joe	ELLIOTT Larry	HABU	
20/01/78	960	14:30	CROWDER Bob	MORGAN John	P2	2.6
23/01/78	960	09:40	KINEGO Joe	ELLIOTT Larry	HABU	4.1
24/01/78	975	13:30	CROWDER Bob	MORGAN John	P2	2.6
25/01/78	967	967	08:15	VETH Jack	KELLER Bill	HABU
27/01/78	960		CROWDER Bob	MORGAN John	HABU	
27/01/78	960		CROWDER Bob	MORGAN John	HABU	
28/01/78	975	10:05	CROWDER Bob	MORGAN John	HABU	4.3
30/01/78	967	09:15	KINEGO Joe	ELLIOTT Larry	HABU	3.7
30/01/78	960		VETH Jack	KELLER Bill	D4	
01/02/78	960	10:15	VETH Jack	ELLIOTT Larry	P2	2.8
03/02/78	967	10:15	CROWDER Bob	MORGAN John	HABU	2.4
03/02/78	960	13:15	MURPHY Jay	BILLINGESLEY John	P2	2.8

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
04/02/78	975	10:10	KINEGO Joe	ELLIOTT Larry	D1	1.1
06/02/78	975	20:33	KINEGO Joe	ELLIOTT Larry	N-HABU	2.3
07/02/78	960	14:30	CROWDER Bob	MORGAN John	D4	2.6
08/02/78	967		MURPHY Jay	BILLINGSLEY John	D3	
09/02/78	967	10:13	MURPHY Jay	BILLINGSLEY John	D4	2.2
10/02/78	960	09:30	KINEGO Joe	ELLIOTT Larry	HABU	4
13/02/78	960	13:15	CROWDER Bob	MORGAN John	HABU	3.9
14/02/78	975	10:33	KINEGO Joe	ELLIOTT Larry	D4	2.2
18/02/78	975	18:00	CROWDER Bob	MORGAN John	N-HABU	2.4
18/02/78	960		CROWDER Bob	MORGAN John	HABU	
20/02/78	960	09:43	MURPHY Jay	BILLINGSLEY John	HABU	3.7
23/02/78	975	16:15	ALISON Tom	VIDA Joe	HABU	2.3
25/02/78	960	14:48	CROWDER Bob	MORGAN John	HABU	2.2
02/03/78	960	16:30	MURPHY Jay	BILLINGSLEY John	N-HABU	2.3
06/03/78	960	13:40	ALISON Tom	VIDA Joe	HABU	2.2
11/03/78	975	19:00	MURPHY Jay	BILLINGSLEY John	N-HABU	0.9
12/03/78	975	19:00	ROSENBERG Maury	PAYNE Al	N-HABU	2.3
14/03/78	960	21:30	ALISON Tom	VIDA Joe	N-HABU	2.4
17/03/78	975	10:00	ROSENBERG Maury	PAYNE Al	HABU	3.8
20/03/78	960	15:16	CARPENDER Buzz	MURPHY John	D4	0.9
22/03/78	975	11:25	ALISON Tom	VIDA Joe	HABU	4.1
22/03/78	960	11:35	ROSENBERG Maury	PAYNE Al	D4	2.5
24/03/78	975	11:30	CARPENDER Buzz	MURPHY John	D8	2.9
29/03/78	975	15:30	ROSENBERG Maury	PAYNE Al	HABU	4.1
30/03/78	975	17:30	CARPENDER Buzz	MURPHY John	N-HABU	2.2
03/04/78	975	18:30	CARPENDER Buzz	MURPHY John	N-HABU	1.9
05/04/78	967	12:15	THOMAS B.C.	REID Jay	D8	4.2
06/04/78	975	11:15	ROSENBERG Maury	PAYNE Al	HABU	4.1
07/04/78	967		CARPENDER Buzz	MURPHY John	D4	
08/04/78	967	11:00	CARPENDER Buzz	MURPHY John	D4	1.2
11/04/78	975	10:10	CARPENDER Buzz	MURPHY John	HABU	3.7
15/04/78	975	10:10	THOMAS B.C.	REID Jay	HABU	4.1
18/04/78	967	10:35	GRAHAM Rich	EMMONS Don	P4	3.9
20/04/78	975	13:16	CARPENDER Buzz	MURPHY John	HABU	2.4
21/04/78	967	11:00	GRAHAM Rich	EMMONS Don	HABU	1.9
21/04/78	975	10:38	CARPENDER Buzz	MURPHY John	RTB FERRY	1.6
24/04/78	967	12:55	THOMAS B.C.	REID Jay	D8	4.1
24/04/78	960	15:30	CARPENDER Buzz	MURPHY John	D9	2.6
25/04/78	975	20:05	CARPENDER Buzz	MURPHY John	N-HABU	2.3
27/04/78	967	13:35	CARPENDER Buzz	MURPHY John	D8	4.2
28/04/78	960	07:30	THOMAS B.C.	REID Jay	HABU	1.9
01/05/78	960	10:00	GRONINGER Bill	SOBER Chuck	D8	1.9
02/05/78	967		GRAHAM Rich	EMMONS Don	HABU	
03/05/78	960	10:27	THOMAS B.C.	REID Jay	D9	1.9
04/05/78	967	09:05	GRAHAM Rich	EMMONS Don	HABU	4.1
08/05/78	960	14:00	GRONINGER Bill	SOBER Chuck	HABU	4.1
09/05/78	967	14:00	THOMAS B.C.	REID Jay	D4	2.5
11/05/78	960	10:00	GRAHAM Rich	SOBER Chuck	D8	1.9
12/05/78	967		GRONINGER Bill	SOBER Chuck	HABU	
13/05/78	967	08:30	GRONINGER Bill	SOBER Chuck	HABU	2.3
15/05/78	975		VETH Jack	ELLIOTT LARRY	D9	
17/05/78	967	12:45	GRAHAM Rich	EMMONS Don	HABU	1.8
19/05/78	967	06:38	VETH Jack	KELLER Bill	HHQ GIANT BARNACLE	1.3
20/05/78	975	06:30	GRAHAM Rich	EMMONS Don	HABU	2.1
21/05/78	967	11:08	VETH Jack	KELLER Bill	RTB FERRY	2.9
22/05/78	967	11:20	GRONINGER Bill	SOBER Chuck	HABU	4.4
25/05/78	967	21:13	VETH Jack	KELLER Bill	N-HABU	2.4
30/05/78	967	11:25	GRONINGER Bill	SOBER Chuck	HABU	2
31/05/78	967	13:25	GRONINGER Bill	SOBER Chuck	HABU	1.6
01/06/78	975	10:30	KINEGO Joe	KELLER Bill	D8	1.8
02/06/78	967	09:30	KINEGO Joe	LIEBMAN Bruce	HABU	4.2
06/06/78	967	13:45	VETH Jack	KELLER Bill	HABU	4.2
08/06/78	975	13:05	KINEGO Joe	LIEBMAN Bruce	P4	2.6
08/06/78	975		KINEGO Joe	LIEBMAN Bruce	P4	
09/06/78	960	11:18	VETH Jack	ELLIOTT Larry	P4/IFC COMPLETED	2.5
12/06/78	975	10:00	CROWDER Bob	MORGAN John	D8	4
13/06/78	967		KINEGO Joe	LIEBMAN Bruce	D5	
15/06/78	960	10:30	KINEGO Joe	LIEBMAN Bruce	HABU	3.9
16/06/78	975	10:30	VETH Jack	LIEBMAN Bruce	D8	4.3
20/06/78	975	21:00	VETH Jack	KELLER Bill	N-HABU	2.4
22/06/78	975	09:27	CROWDER Joe	MORGAN John	HABU	2.3
23/06/78	975	11:40	KINEGO Joe	LIEBMAN Bruce	HABU	3.9
26/06/78	960	11:54	KECK Tom	SHAW Tim	D8	3.9
26/06/78	960		KECK Tom	SHAW Tim	D8	
27/06/78	967	10:28	CROWDER Joe	MORGAN John	P4	5.7
28/06/78	960	09:30	KECK Tom	SHAW Tim	HABU	0.7
29/06/78	960	09:51	KECK Tom	SHAW Tim	HABU	4.3
30/06/78	975	10:00	KINGO Joe	LIEBMAN Bruce	D3	2.5
05/07/78	960	09:15	KECK Tom	SHAW Tim	D3	2.5
06/07/78	967	21:25	CROWDER Joe	MORGAN John	N-HABU	2.3
10/07/78	967	10:00	ALISON Tom	VIDA Joe	D8	3.8
12/07/78	960	06:00	KECK Tom	SHAW Tim	HABU	4.3
14/07/78	967	10:10	CROWDER Joe	MORGAN Juhn	HABU	2.9
17/07/78	967	13:15	ALISON Tom	VIDA Joe	HABU	2.2
18/07/78	960	10:00	KECK Tom	SHAW Tim	D8	4
21/07/78	967	14:44	KECK Tom	SHAW Tim	HABU	4.2
24/07/78	960	18:31	ALISON Tom	VIDA Joe	HABU	1.1
26/07/78	967	07:15	ALISON Tom	VIDA Joe	HABU	3.9
30/07/78	967	12:15	CARPENDER Buzz	MURPHY John	HABU	0.5
31/07/78	967	12:154	CARPENDER Buzz	MURPHY John	HABU	2.3
01/08/78	960	09:27	KECK Tom	SHAW Tim	HABU	3.2
03/08/78	960	14:55	ALISON Tom	VIDA Joe	HABU	3.7
05/08/78	967	09:33	CARPENDER Buzz	MURPHY John	HABU	2.3
07/08/78	960	09:15	THOMAS B.C.	REID Jay	HABU	1.8
09/08/78	975		ALISON Tom	VIDA Joe	P4	
10/08/78	975	14:20	ALISON Tom	VIDA Joe	D8	3.8
11/08/78	967	13:16	CARPENDER Buzz	MURPHY John	D7	2.4
14/08/78	975	10:15	THOMAS B.C.	REID Jay	FCF2	1.9
18/08/78	975	04:02	CARPENDER Buzz	MURPHY John	HABU	4.1
21/08/78	975	09:16	THOMAS B.C.	REID Jay	HABU	2.8
23/08/78	975	11:24	GRAHAM Rich	EMMONS Don	HABU	3.6
24/08/78	960	12:14	CARPENDER Buzz	MURPHY John	FCF2	2.7
24/08/78	960		CARPENDER Buzz	MURPHY John	FCF2	
25/08/78	967	09:15	CARPENDER Buzz	MURPHY John	HABU	3.8
28/08/78	967	10:34	GRAHAM Rich	EMMONS Don	D8	2.2
28/08/78	960	12:35	THOMAS B.C.	REID Jay	D7	2.5
29/08/78	975	21:24	THOMAS B.C.	REID Jay	N-HABU	1.7
30/08/78	975	21:43	THOMAS B.C.	REID Jay	N-HABU	2.1
01/09/78	967		GRAHAM Rich	EMMONS Don	HABU	
05/09/78	975	21:04	GRAHAM Rich	EMMONS Don	N-HABU	2.2
06/09/78	960	14:41	CROWDER Bob	MORGAN John	D8	2.5
08/09/78	960	11:30	CROWDER Bob	MORGAN John	HABU	4.2
08/09/78	975	12:45	THOMAS B.C.	REID Jay	D1	1.2
11/09/78	960	10:35	THOMAS B.C.	REID Jay	HABU	3.9
12/09/78	975	10:35	GRAHAM Rich	EMMONS Don	HABU	2.1
14/09/78	960	09:58	CROWDER Bob	MORGAN John	D4	2.5
15/09/78	975	11:00	CROWDER Bob	MORGAN John	HABU	4.1
18/09/78	960	12:53	GRONINGER Bill	SOBER Chuck	D8	4.2
19/09/78	975	21:30	GRAHAM Rich	EMMONS Don	N-HABU	2.4
20/09/78	960	13:00	CROWDER Bob	MORGAN John	FCF2	2.5
22/09/78	975	04:30	GRONINGER Bill	SOBER Chuck	HABU	4.3
25/09/78	960	09:40	CROWDER Bob	MORGAN John	HABU	3.7
25/09/78	975	10:48	GRAHAM Rich	EMMONS Don	D1	1.2
26/09/78	967	10:20	GRONINGER Bill	SOBER Chuck	FCF2	4.1
28/09/78	975	14:45	GRONINGER Bill	SOBER Chuck	HABU	2.2
29/09/78	967	10:15	CROWDER Bob	MORGAN John	D8	4
02/10/78	967	13:04	CROWDER Bob	MORGAN John	HABU	2.3
04/10/78	967	09:01	VETH Jack	KELLER Bill	HABU	4.3
05/10/78	975	10:15	VETH Jack	KELLER Bill	D8	4.2
06/10/78	967	10:00	CROWDER Bob	MORGAN John	HABU	2.4
10/10/78	975	13:48	VETH Jack	KELLER Bill	HABU	1.1
10/10/78	967	14:19	CROWDER Bob	MORGAN John	HABU	4.4
12/10/78	960		VETH Jack	KELLER Bill	D7	
16/10/78	960	13:29	KECK Tom	SHAW Tim	D1	1
16/10/78	967	11:15	GRONINGER Bill	SOBER Chuck	HABU	2.4
17/10/78	967	19:45	VETH Jack	KELLER Bill	N-HABU	2.3
19/10/78	967	07:10	KECK Tom	SHAW Tim	HABU	1.4
20/10/78	967	15:00	KECK Tom	SHAW Tim	HABU	3.9
22/10/78	960	12:10	GRONINGER Bill	SOBER Chuck	HABU	1.4
24/10/78	960	21:00	VETH Jack	KELLER Bill	N-HABU	2
25/10/78	967	21:15	VETH Jack	KELLER Bill	N-HABU	2.3
26/10/78	960	12:00	GRONINGER Bill	SOBER Chuck	HABU	1.4
28/10/78	960	10:15	KECK Tom	SHAW Tim	HABU	1.3
30/10/78	967	07:10	KECK Tom	SHAW Tim	HABU	4.3
31/10/78	960	12:15	VETH Jack	KELLER Bill	HABU	0.9
01/11/78	967	21:45	VETH Jack	KELLER Bill	N-HABU	2.1
03/11/78	967	10:10	KINEGO Joe	LIEBMAN Bruce	HABU	4.1
03/11/78	975	13:19	KECK Tom	SHAW Tim	D4	2.6
06/11/78	960	14:21	KECK Tom	SHAW Tim	HABU	4.4
08/11/78	967	06:00	VETH Jack	KELLER Bill	HABU	2.5
09/11/78	960	13:00	KINEGO Joe	LIEBMAN Bruce	FCF2	4.2
11/11/78	960	07:00	KINEGO Joe	LIEBMAN Bruce	HABU	4.4
13/11/78	960	09:31	KECK Tom	SHAW Tim	HABU	1.4
14/11/78	975	10:04	PETERS Dave	BETHART Ed	D4	1.4
15/11/78	960	09:05	PETERS Dave	BETHART Ed	HABU	4.1
16/11/78	960	20:20	KINEGO Joe	LIEBMAN Bruce	N-HABU	3.2
17/11/78	975	13:00	KECK Tom	SHAW Tim	D8	3.4
20/11/78	967	13:00	KECK Tom	SHAW Tim	HABU	4.2
23/11/78	967	21:00	KINEGO Joe	LIEBMAN Bruce	N-HABU	2.3
27/11/78	967	11:15	PETERS Dave	BETHART Ed	HABU	4.1
28/11/78	975	10:02	CARPENTER Buzz	MURPHY John	D2	2.2
29/11/78	967	10:43	PETERS Dave	BETHART Ed	RTP FERRY	1.9
30/11/78	967	10:30	KINEGO Joe	LIEBMAN Bruce	HABU	2.4
01/12/78	975	10:05	CARPENTER Buzz	MURPHY John	D8	4.1

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
04/12/78	975	11:45	CARPENTER Buzz	MURPHY John	HABU	4.3
05/12/78	967		PETERS Dave	BETHART Ed	HABU	
06/12/78	975		CARPENTER Buzz	MURPHY John	RTB FERRY	
07/12/78	975	11:22	CARPENTER Buzz	MURPHY John	RTB FERRY	1.8
09/12/78	975	11:10	CARPENTER Buzz	MURPHY John	HABU	2.2
11/12/78	967	12:40	ALISON Tom	VIDA Joe	HABU	2.9
11/12/78	960	14:44	CARPENTER Buzz	BETHART Ed	P2	2.2
13/12/78	960	09:58	CARPENTER Buzz	MURPHY John	FCF2	2.4
13/12/78	967	14:47	ALISON Tom	VIDA Joe	RTB FERRY	1.6
14/12/78	960	11:01	CARPENTER Buzz	MURPHY John	HABU	2.5
15/12/78	967	12:00	ALISON Tom	VIDA Joe	HABU	1.2
16/12/78	967	11:15	ALISON Tom	VIDA Joe	HABU	4.2
19/12/78	967	10:45	CARPENTER Buzz	MURPHY John	N-HABU	2.4
20/12/78	960	15:08	PENTERS Dave	BETHART Ed	FCF2	2.3
20/12/78	960		PENTERS Dave	BETHART Ed	FCF2	
21/12/78	967	10:30	ALISON Tom	VIDA Joe	HABU	3.7
27/12/78	960	13:19	CARPENTER Buzz	MURPHY John	HABU	1.4
28/12/78	960	10:04	CARPENTER Buzz	MURPHY John	HABU	4.3
29/12/78	967	11:00	THOMAS B.C.	REID Jay	HABU	2.3
02/01/79	975	10:31	CARPENTER Buzz	MURPHY John	FCF	2.6
02/01/79	960	10:30	ALISON Tom	VIDA Joe	HABU	3.8
04/01/79	960	14:10	THOMAS B.C.	REID Jay	HABU	2.4
05/01/79	975	10:00	ALISON Tom	VIDA Joe	FCF	4
06/01/79	960	09:11	ALISON Tom	VIDA Joe	HABU	1.4
08/01/79	975	09:43	GRONINGER Bill	SOBER Chuck	FCF	4.1
09/01/79	975	10:15	GRONINGER Bill	SOBER Chuck	HABU	2.1
11/01/79	960	19:10	THOMAS B.C.	REID Jay	N-HABU	2.4
15/01/79	975	08:10	ALISON Tom	VIDA Joe	HABU	3.9
17/01/79	967	13:45	THOMAS B.C.	REID Jay	HABU	3.1
17/01/79	960	12:55	GRONINGER Bill	SOBER Chuck	HABU	1.5
19/01/79	975	20:05	GRONINGER Bill	SOBER Chuck	N-HABU	2.3
21/01/79	975	10:09	THOMAS B.C.	REID Jay	HABU	1.3
24/01/79	960	10:00	THOMAS B.C.	REID Jay	HABU	2.4
26/01/79	960	18:30	GRAHAM Rich	EMMONS Don	N-HABU	1.3
30/01/79	960	09:16	GRONINGER Bill	SOBER Chuck	HABU	2.4
31/01/79	967	11:16	THOMAS B.C.	REID Jay	HABU	2.4
03/02/79	960	10:30	GRAHAM Rich	EMMONS Don	HABU	1.5
05/02/79	960	19:00	GRONINGER Bill	SOBER Chuck	N-HABU	2.3
07/02/79	960	13:15	GRAHAM Rich	EMMONS Don	HABU	1.6
08/02/79	967	09:30	SHELTON Lee	MACKEAN Barry	FCF2	2.5
09/02/79	967	08:33	SHELTON Lee	MACKEAN Barry	HABU	2.5
12/02/79	960	20:16	GRONINGER Bill	SOBER Chuck	N-HABU	2.1
15/02/79	967	10:10	GRAHAM Rich	EMMONS Don	HABU	2.4
16/02/79	960	11:50	SHELTON Lee	MACKEAN Barry	HABU	4.1
19/02/79	960	08:00	GRAHAM Rich	EMMONS Don	HABU	4
22/02/79	967	09:28	VETH Jack	KELLER Bill	HABU	2.3
23/02/79	960	13:42	SHELTON Lee	MACKEAN Barry	HABU	3.9
23/02/79	960		SHELTON Lee	MACKEAN Barry	HABU	
26/02/79	967	21:30	GRAHAM Rich	EMMONS Don	N-HABU	2.1
27/02/79	967		VETH Jack	KELLER Bill	HABU	
27/02/79	975	11:47	VETH Jack	KELLER Bill	FCF2	4.3
02/03/79	967	13:10	SHELTON Lee	MACKEAN Barry	HABU	4.5
05/03/79	975	10:11	KINEGO Joe	LIEBMAN Bruce	FCF2	4.3
06/03/79	967	10:35	VETH Jack	KELLER Bill	HABU	4.2
08/03/79	975	22:00	KINEGO Joe	LIEBMAN Bruce	N-HABU	1.2
10/03/79	960	12:00	SHELTON Lee	MACKEAN Barry	HABU	2.1
12/03/79	975	10:00	VETH Jack	KELLER Bill	FCF2	2.2
13/03/79	960	09:10	VETH Jack	KELLER Bill	HABU	4.1
16/03/79	960	23:10	KINEGO Joe	LIEBMAN Bruce	N-HABU	2.4
20/03/79	960	10:15	VETH Jack	KELLER Bill	HABU	2.4
22/03/79	960	19:45	CROWDER Bob	MORGAN John	N-HABU	2.4
24/03/79	975	11:30	KINEGO Joe	LIEBMAN Bruce	HABU	3.9
25/03/79	960	10:00	VETH Jack	KELLER Bill	HABU	0.5
25/03/79	960	12:14	VETH Jack	KELLER Bill	HABU	1.6
27/03/79	975	10:15	CROWDER Bob	MORGAN John	HABU	2.3
30/03/79	960	09:10	KINEGO Joe	LIEBMAN Bruce	HABU	4.2
02/04/79	975	18:05	CROWDER Bob	MORGAN John	N-HABU	2.3
04/04/79	967		KECK Tom	SHAW Tim	HABU	
05/04/79	960	09:10	KECK Tom	SHAW Tim	HABU	1.4
06/04/79	967	16:00	KINEGO Joe	LIEBMAN Bruce	HABU	2.2
10/04/79	975	12:45	CROWDER Bob	MORGAN John	HABU	4.1
11/04/79	967		KECK Tom	SHAW Tim	FCT2	
11/04/79	967	10:05	KECK Tom	SHAW Tim	FCT2	4
12/04/79	960	19:30	KECK Tom	SHAW Tim	N-HABU	2.5
14/04/79	967	09:30	CROWDER Bob	MORGAN John	HABU	4.4
16/04/79	975	21:45	PETERS Dave	BETHART Ed	N-HABU	2.2
18/04/79	960	10:55	KECK Tom	SHAW Tim	HABU	4.1
20/04/79	975	10:21	CROWDER Bob	MORGAN John	HABU	2.1
20/04/79	975		CROWDER Bob	MORGAN John	HABU	
23/04/79	975	23:30	PETERS Dave	BETHART Ed	N-HABU	2.2
27/04/79	967	13:47	KECK Tom	SHAW Tim	HABU	4.1
28/04/79	960	10:35	PETERS Dave	BETHART Ed	HABU	1.4
30/04/79	967	12:09		ALISON Tom	VIDA Joe	FCF2

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
02/05/79	975	09:40	KECK Tom	SHAW Tim	HABU	2.4
03/05/79	960		PETERS Dave	BETHART Ed	D4	
04/05/79	960	16:31	PETERS Dave	BETHART Ed	FCF1	2.3
04/05/79	967	16:30	ALISON Tom	VIDA Joe	HABU	2.3
07/05/79	967	09:05	KECK Tom	SHAW Tim	HABU	4.1
10/05/79	975	10:30	ALISON Tom	VIDA Joe	D1	1.2
11/05/79	967	08:00	PETERS Dave	BETHART Ed	HABU	1.2
12/05/79	960	10:00	ALISON Tom	VIDA Joe	HABU	2.3
14/05/79	967		PETERS Dave	BETHART Ed	HABU	
15/05/79	975	13:00	ALISON Tom	VIDA Joe	D8	4.1
16/05/79	960	19:30	PETERS Dave	BETHART Ed	N-HABU	2.3
18/05/79	975	11:43	CARPENDER Buzz	MURPHY John	HABU	1.8
19/05/79	967	09:50	ALISON Tom	VIDA Joe	HABU	4.1
21/05/79	975	13:15	PETERS Dave	BETHART Ed	HABU	0.5
25/05/79	960	14:10	ALISON Tom	VIDA Joe	HABU	4.1
29/05/79	967	20:10	CARPENDER Buzz	MURPHY John	N-HABU	2.1
01/06/79	975	10:00	PETERS Dave	BETHART Ed	FCF	2.3
02/06/79	967	11:25	ALISON Tom	VIDA Joe	HABU	4.2
04/06/79	960	17:15	CARPENDER Buzz	MURPHY John	N-HABU	4.1
05/06/79	975		ALISON Tom	VIDA Joe	?	
07/06/79	967	13:32	CARPENDER Buzz	MURPHY John	HABU	4
09/06/79	975	09:05	CARPENDER Buzz	MURPHY John	HABU	4.1
13/06/79	967	15:05	GRAHAM Rich	EMMONS Don	HABU	2.1
15/06/79	975	09:05	GRONINGER Bill	SOHER Chuck	HABU	2.5
18/06/79	967	14:11	CARPENDER Buzz	MURPHY John	HABU	4.4
19/06/79	960	23:00	GRAHAM Rich	EMMONS Don	FCF	2.3
20/06/79	975	14:11	GRONINGER Bill	SOBER Chuck	HABU	2.4
22/06/79	962	02:00	SHELTON Lee	MacKEAN Larry	FERRY IN - H	6.7
23/06/79	960	06:00	CARPENDER Buzz	MURPHY John	II-FERRY OUT	
25/06/79	975	09:10	GRAHAM Rich	EMMONS Don	HABU	4.1
26/06/79	967	19:25	GRONINGER Bill	SOBER Chuck	N-HABU	2.3
28/06/79	975	10:43	SHELTON Lee	MacKEAN Larry	HABU	4.1
02/07/79	975	10:02	GRAHAM Rich	EMMONS Don	HABU	5.2
05/07/79	962	20:20	SHELTON Lee	MacKEAN Larry	N-HABU	2.5
09/07/79	967	14:09	GRAHAM Rich	EMMONS Don	HABU	4.2
11/07/79	975		THOMAS B.C.	REID Jay	HABU	
11/07/79	975	06:23	SHELTON Lee	MacKEAN Larry	HABU	1.4
11/07/79	962	03:58	THOMAS B.C.	REID Jay	HHQ SPECIAL - NIGHT GLOBAL SHIELD	4.5
11/07/79	975	10:45	GRAHAM Rich	EMMONS Don	HABU	4
16/07/79	975	18:45	SHELTON Lee	MacKEAN Larry	N-HABU	2.3
19/07/79	972	02:00	KINEGO Joe	KELLER Bill	FERRY IN / HABU	6.4
20/07/79	967	08:15	SHELTON Lee	MacKEAN Larry	HABU	2.3
20/07/79	975	06:00	GRAHAM Rich	EMMONS Don	II-FERRY OUT	
24/07/79	962	09:13	THOMAS B.C.	REID Jay	N-HABU	2.3
25/07/79	962	09:35	KINEGO Joe	KELLER Bill	HABU	2.2
27/07/79	962	09:45	SHELTON Lee	MacKEAN Barry	HABU	3.8
30/07/79	972	09:45	THOMAS B.C.	REID Jay	HABU	4.1
31/07/79	967	10:00	KINEGO Joe	KELLER Bill	FCF	2.1
02/08/79	979	02:03	VETH Jack	MACHOREK Bill	FERRY IN / HABU	6.1
03/08/79	967	06:00	SHELTON Lee	MACKEAN Larry	FERRY OUT	
06/08/79	962		THOMAS B.C.	REID Jay	HABU	
06/08/79	962	13:26	THOMAS B.C.	REID Jay	HABU	4.2
07/08/79	972	19:50	KINEGO Joe	KELLER Bill	N-HABU	2.3
10/08/79	962	10:15	VETH Jack	MACHOREK Bill	HABU	3.8
11/08/79	979	08:30	THOMAS B.C.	REID Jay	HABU	2.4
20/08/79	979	13:43	VETH Jack	MACHOREK Bill	FCF	2.2
25/08/79	972	11:30	YOUNG Rich	SZCZEPANIK Russ	FCF	2.5
27/08/79	962	15:22	VETH Jack	MACHOREK Bill	HABU	4.1
30/08/79	979	08:05	YOUNG Rich	SZCZEPANIK Russ	HABU	3.9
31/08/79	962	20:05	VETH Jack	MACHOREK Bill	N-HABU	2.3
03/09/79	972	10:05	YOUNG Rich	SZCZEPANIK Russ	HABU	2.6
05/09/79	962	10:25	ALISON Tom	VIDA Joe	HABU	2.3
07/09/79	962	18:00	VETH Jack	MACHOREK Bill	N-HABU	2.2
10/09/79	979	21:20	ALISON Tom	VIDA Joe	N-HABU	2.3
11/09/79	972	13:30	VETH Jack	MACHOREK Bill	FCF	2.4
12/09/79	962	12:15	YOUNG Rich	SZCZEPANIK Russ	HABU	3.2
14/09/79	979	09:10	ALISON Tom	VIDA Joe	HABU	4.3
17/09/79	979	10:35	YOUNG Rich	SZCZEPANIK Russ	HABU	4
18/09/79	979	22:30	KECK Tom	SHAW Tim	N-HABU	2.4
19/09/79	972		ALISON Tom	VIDA Joe	FCF	
20/09/79	962	11:10	ALISON Tom	VIDA Joe	HABU	3.7
21/09/79	972	14:47	KECK Tom	SHAW Tim	FCF	2.5
21/09/79	962	14:46	YOUNG Rick	SZCZEPANIK Russ	HABU	4.1
24/09/79	972	10:15	ALISON Tom	VIDA Joe	HABU	3.5
01/10/79	979	11:30	KECK Tom	SHAW Tim	HABU	4.2
03/10/79	972	19:40	ALISON Tom	VIDA Joe	N-HABU	2.3
05/10/79	979	12:30	KECK Tom	SHAW Tim	HABU	2.3
10/10/79	972	09:05	PETERS Dave	BETHART Ed	HABU	2.3
11/10/79	972	13:45	ALISON Tom	VIDA Joe	HABU	3.8
13/10/79	979	10:40	KECK Tom	SHAW Tim	HABU	2.2
20/10/79	972	15:05	PETERS Dave	BETHART Ed	HABU	2.3

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
22/10/79	962	13:59	KECK Tom	SHAW Tim	FCF	4.3
22/10/79	979	20:02	GRAHAM Rich	EMMONS Don	N-HABU	2.3
24/10/79	972	11:15	PETERS Dave	BETHART Ed	HABU	2.4
25/10/79	979	22:15	KECK Tom	SHAW Tim	N-HABU	2.4
29/10/79	962	09:17	GRAHAM Rich	EMMONS Don	HABU	3.9
30/10/79	979	20:20	CARPENTER Buzz	SOHER Chuck	N-HABU	2.1
05/11/79	972	19:25	PETER Dave	BETHART Ed	N-HABU	2.4
07/11/79	962	11:45	GRAHAM Rich	EMMONS Don	HABU	3.7
08/11/79	979	10:45	CARPENTER Buzz	SOHER Chuck	HABU	2.4
09/11/79	972	18:40	GRAHAM Rich	EMMONS Don	N-HABU	2.3
13/11/79	962	07:40	CARPENTER Buzz	SOHER Chuck	HABU	2.4
14/11/79	972	19:05	GRAHAM Rich	EMMONS Don	N-HABU	2.3
16/11/79	962	12:15	THOMAS B.C.	REID Jay	HABU	4.2
21/11/79	979	15:10	CARPENTER Buzz	SOHER Chuck	N-HABU	4.8
24/11/79	972	10:30	SHELTON Lee	MacKEAN Barry	HABU	2.2
26/11/79	962	11:45	CARPENTER Buzz	SOHER Chuck	HABU	3.9
27/11/79	972	20:10		SHELTON Lee	MacKEAN Barry	N-HABU
29/11/79	979	14:50	CARPENTER Buzz	SOHER Chuck	HABU	2.4
03/12/79	962	18:55	SHECTON Lee	MacKEAN Barry	N-HABU	2.3
05/12/79	972	09:05	CARPENTER Buzz	SOBER Chuck	HABU	4.2
10/12/79	979	13:00	SHECTON Lee	MacKEAN Barry	HABU	2.3
12/12/79	962	07:55	THOMAS B.C.	REID Jay	HABU	4
13/12/79	979	17:45	SHECTON Lee	MacKEAN Barry	N-HABU	2.3
14/12/79	962	12:30	THOMAS B.C.	REID Jay	HABU	4
17/12/79	962	09:25	SHECTON Lee	MacKEAN Barry	HABU	4.3
18/12/79	979	21:45	THOMAS B.C.	REID Jay	N-HABU	2.3
20/12/79	962	12:30	THOMAS B.C.	REID Jay	HABU	2.3
21/12/79	979	11:15	SHECTON Lee	MacKEAN Barry	HABU	2.3
27/12/79	962	13:15	YOUNG Rich	SZCZEPANIK Russ	HABU	4.3
29/12/79	979	08:21	SHECTON Lee	MacKEAN Barry	HABU	3.9
03/01/80	962		YOUNG Rich	SZCZEPANIK Russ	N-HABU	
03/01/80	962	21:30	YOUNG Rich	SZCZEPANIK Russ	N-HABU	2.5
04/01/80	972	15:30	SHELTON Lee	MacKEAN Barry	FCF-2	2
05/01/80	979		YOUNG Rich	SZCZEPANIK Russ	HABU	
07/01/80	962	09:05	YOUNG Rich	SZCZEPANIK Russ	HABU	4.2
09/01/80	979	11:10	ALISON Tom	VIDA Joe	HABU	4.2
10/01/80	962	10:55	SHELTON Lee	MacKEAN Barry	HABU	2.3
15/01/80	972		YOUNG Rich	SZCZEPANIK Russ	HABU	
16/01/80	972	10:00	YOUNG Rich	SZCZEPANIK Russ	HABU	2.3
17/01/80	979	20:20	ALISON Tom	VIDA Joe	N-HABU	2.3
19/01/80	962	10:20	YOUNG Rich	SZCZEPANIK Russ	HABU	2.7
21/01/80	962	10:00	ALISON Tom	VIDA Joe	HABU	2.3
22/01/80	962	19:05	KECK Tom	SHAW Tim	HABU	2.4
24/01/80	962	10:46	YOUNG Rich	SZCZEPANIK Russ	HABU	2.3
25/01/80	962	14:30	ALISON Tom	VIDA Joe	HABU	3.8
28/01/80	979	07:30	KECK Tom	SHAW Tim	HABU	1.9
29/01/80	972	09:20	YOUNG Rich	SZCZEPANIK Russ	HABU	2.4
30/01/80	979	20:15	ALISON Tom	VIDA Joe	N-HABU	2.4
01/02/80	979	10:50	KECK Tom	SHAW Tim	HABU	2.3
01/02/80	972	10:51	YOUNG Rich	SZCZEPANIK Russ	FCF	1.2
04/02/80	962	19:00	KECK Tom	SHAW Tim	HABU	2.6
05/02/80	972	15:00	ALISON Tom	VIDA Joe	FCF	2.3
07/02/80	979	07:15	ALISON Tom	VIDA Joe	HABU	4.1
09/02/80	972	07:35	PETER Dave	BETHART Ed	HABU	2.5
11/02/80	979	09:55	KECK Tom	SHAW Tim	HABU	4.3
12/02/80	962	22:45	ALISON Tom	SHAW Tim	N-HABU	2.1
15/02/80	972	10:30	PETER Dave	BETHART Ed	HABU	1.8
17/02/80	979	09:15	KECK Tom	SHAW Tim	HABU	5.9
20/02/80	962	18:45	CROWDER Bob	EMMONS Don	N-HABU	2.3
22/02/80	972	13:12	KECK Tom	SHAW Tim	HABU	4.1
25/02/80	979	09:05	PETER Dave	BETHART Ed	HABU	2.3
25/02/80	972	09:06	CROWDER Bob	EMMONS Don	FCF	4.1
27/02/80	972	12:10	KECK Tom	SHAW Tim	HABU	3.9
28/02/80	962	11:36	PETER Dave	BETHART Ed	HABU	2.1
03/03/80	962	20:05	CROWDER Bob	EMMONS Don	N-HABU	2.3
05/03/80	972	10:10	CARPENTER Buzz	SOBER Chuck	HABU	4.2
06/03/80	962	15:50	CROWDER Bob	EMMONS Don	HABU	2.3
10/03/80	972	07:50	CARPENTER Buzz	SOBER Chuck	HABU	4.2
11/03/80	962	22:05	CROWDER Bob	EMMONS Don	N-HABU	2.4
15/03/80	972	10:38	CARPENTER Buzz	SOBER Chuck	HABU	2.4
17/03/80	962	18:50	CROWDER Bob	EMMONS Don	N-HABU	2.2
18/03/80	979	13:00	THOMAS B.C.	REID Jay	FCF	4.3
19/03/80	972	13:33	CARPENTER Buzz	SOBER Chuck	HABU	3.9
23/03/80	979	08:40	CROWDER Bob	EMMONS Don	HABU	3.8
24/03/80	972	11:30	THOMAS B.C.	REID Jay	HABU	4
25/03/80	962	21:20	CARPENTER Buzz	SOBER Chuck	N-HABU	2.3
27/03/80	979	11:00	CROWDER Bob	EMMONS Don	HABU	2.4
28/03/80	962	22:00	THOMAS B.C.	REID Jay	N-HABU	2.4
29/03/80	972	19:10	CARPENTER Buzz	SOBER Chuck	N-HABU	2.3
31/03/80	979		KINEGO Joe	KELLER Bill	HABU	A
31/03/80	979	18:53	KINEGO Joe	KELLER Bill	N-HABU	2.3
02/04/80	962	19:05	THOMAS B.C.	REID Jay	N-HABU	2.4
04/04/80	972	10:35	CARPENTER Buzz	SOBER Chuck	HABU	1.4

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
07/04/80	979		CARPENTER Buzz	SOBER Chuck	N-HABU	
07/04/80	979	13:44	CARPENTER Buzz	SOBER Chuck	HABU	0.5
08/04/80	979	19:19	CARPENTER Buzz	SOBER Chuck	N-HABU	2.4
12/04/80	962	09:15	KINEGO Joe	KELLER Bill	HABU	4.1
14/04/80	972	10:46	THOMAS B.C.	REID Jay	HABU	4.4
15/04/80	962	20:30	SHELTON Lee	MacKEAN Barry	N-HABU	2.4
17/04/80	979	12:20	KINEGO Joe	KELLER Bill	HABU	1.9
19/04/80	972	09:51	THOMAS B.C.	REID Jay	HABU	2.5
21/04/80	962	10:30	SHELTON Lee	MacKEAN Barry	HABU	2.4
23/04/80	979	09:25	THOMAS B.C.	REID Jay	HABU	2.5
24/04/80	972	21:40	KINEGO Joe	KELLER Bill	N-HABU	2.2
29/04/80	971	11:15	SHELTON Lee	MacKEAN Barry	HABU	4.4
01/05/80	979	10:30	KINEGO Joe	KELLER Bill	HABU	2.3
03/05/80	979	09:15	YOUNG Rich	SZCZEPANIK Russ	HABU	6
05/05/80	962	10:00	SHELTON Lee	MacKEAN Barry	FCF	2.5
06/05/80	972	18:30	KINEGO Joe	KELLER Bill	N-HABU	2.3
07/05/80	979	19:15	YOUNG Rich	SZCZEPANIK Russ	N-HABU	2.3
09/05/80	962	09:05	SHELTON Lee	MacKEAN Barry	HABU	2.6
12/05/80	962	13:08	YOUNG Rich	SZCZEPANIK Russ	HABU	2.5
13/05/80	972	21:05	ALISON Tom	VIDA Joe	N-HABU	2.3
15/05/80	979	12:30	SHELTON Lee	MacKEAN Barry	HABU	2.4
19/05/80	962	11:15	YOUNG Rich	SZCZEPANIK Russ	HABU	4.4
23/05/80	972	20:45	ALISON Tom	VIDA Joe	N-HABU	2.5
28/05/80	979	09:30	YOUNG Rich	SZCZEPANIK Russ	HABU	2.4
30/05/80	962	06:00	KECK Tom	SHAW Tim	HABU	4.3
02/06/80	979	11:30	ALISON Tom	VIDA Joe	HABU	2.4
04/06/80	962	11:09	YOUNG Rich	SZCZEPANIK Russ	HABU	2.3
05/06/80	962	20:40	KECK Tom	SHAW Tim	N-HABU	2.4
09/06/80	979	21:05	ALISON Tom	VIDA Joe	N-HABU	2.3
11/06/80	962	19:55	PETER Dave	BETHART Ed	N-HABU	2.3
13/06/80	972	14:50	KECK Tom	SHAW Tim	HABU	4.1
16/06/80	962	09:10	ALISON Tom	VIDA Joe	HABU	2.3
18/06/80	979	07:20	KECK Tom	SHAW Tim	HABU	3.8
19/06/80	962	20:50	ALISON Tom	VIDA Joe	N-HABU	2.3
21/06/80	979	07:02	PETER Dave	BETHART Ed	FCF	2.3
21/06/80	972	09:23	ALISON Tom	VIDA Joe	H-FERRY OUT	
21/06/80	962	09:42	KECK Tom	SHAW Tim	H-FERRY OUT AIR SPARE	1.3
24/06/80	976	03:08	CROWDER Bob	EMMONS Don	FERRY IN-H	5.7
26/06/80	979	12:10	PETER Dave	BETHART Ed	HABU	3.3
28/06/80	976	12:00	KECK Tom	SHAW Tim	HABU	2.9
01/07/80	962	10:05	CROWDER Bob	EMMONS Don	SPECIAL	4.4
03/07/80	979		PETER Dave	BETHART Ed	HABU	
04/07/80	962	10:55	CROWDER Bob	EMMONS Don	SPECIAL RTS FERRY	4.9
05/07/80	979	12:00	PETER Dave	BETHART Ed	HABU	2.3
08/07/80	979	09:05	CROWDER Bob	EMMONS Don	HABU	4.1
09/07/80	962	20:40	PETER Dave	BETHART Ed	N-HABU	2.1
10/07/80	976	12:00	BERTHELSON Gil	STAMPF Frank	FCF	4.1
11/07/80	979	11:10	BERTHELSON Gil	STAMPF Frank	HABU	4
14/07/80	976	08:10	CROWDER Bob	EMMONS Don	HABU	3.9
15/07/80	962	21:50	PETER Dave	BETHART Ed	N-HABU	2.2
17/07/80	958	08:30	THOMAS B.C.	REID Jay	FERRY IN-H	6.3
19/07/80	962	09:15	PETER Dave	BETHART Ed	H-FERRY OUT	
21/07/80	979		BERTHELSON Gil	STAMPF Frank	HABU	
21/07/80	979	12:40	BERTHELSON Gil	STAMPF Frank	HABU	2.3
21/07/80	958	10:30	CROWDER Bob	EMMONS Don	HABU	4.1
24/07/80	976	20:00	THOMAS B.C.	REID Jay	N-HABU	2.2
29/07/80	976	06:00	BERTHELSON Gil	STAMPF Frank	HABU	4.2
30/07/80	979	13:10	CROWDER Bob	EMMONS Don	HABU	2.4
01/08/80	976	09:15	THOMAS B.C.	REID Jay	HABU	1.9
03/08/80	979	08:15	BERTHELSON Gil	STAMPF Frank	HABU	6.2
05/08/80	976	10:10	CARPENTER Buzz	KELLER Bill	HABU	3.8
07/08/80	958	14:05	BERTHELSON Gil	STAMPF Frank	HABU	4.1
11/08/80	976	07:55	CARPENTER Buzz	KELLER Bill	HABU	3.9
12/08/80	979	20:03	THOMAS B.C.	REID Jay	N-HABU	2.3
14/08/80	976	10:42	BERTHELSON Gil	STAMPF Frank	HABU	2.4
19/08/80	958	11:19	CARPENTER Buzz	KELLER Bill	HABU	4.1
20/08/80	979	21:10	THOMAS B.C.	REID Jay	N-HABU	2.2
23/08/80	958	12:50	SHELTON Lee	MacKEAN Barry	HABU	2.3
25/08/80	979	20:50	CARPENTER Buzz	KELLER Bill	N-HABU	2.1
26/08/80	976	10:03	THOMAS B.C.	REID Jay	FCF	2.2
29/08/80	979	12:13	SHELTON Lee	MacKEAN Barry	HABU	2.5
02/09/80	979	19:59	CARPENTER Buzz	KELLER Bill	N-HABU	2.3
04/09/80	976	09:44	SHELTON Lee	MacKEAN Barry	HABU	2.4
04/09/80	960	05:57	ALISON Tom	VIDA Joe	H-FERRY IN	6.2
05/09/80	979	10:30	CARPENTER Buzz	KELLER Bill	H/FERRY OUT	
08/09/80	958	10:15	YOUNG Rick	SZCZEPANIK Russ	HABU	2.2
12/09/80	976	14:00	SHELTON Le	MacKEAN Barry	HABU	2.3
16/09/80	960	08:00	ALISON Tom	VIDA Joe	HABU	4.2
17/09/80	998		YOUNG Rick	SZCZEPANIK Russ	HABU	
18/09/80	958	21:10	YOUNG Rick	SZCZEPANIK Russ	N-HABU	2.4
20/09/80	960	09:10	SHELTON Lee	MacKEAN Barry	HABU	2.3

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
22/09/80	958	12:05	ALISON Tom	VIDA Joe	HABU	4.1
24/09/08	976	08:20	YOUNG Rick	SZCZEPANIK Russ	HABU	0.4
25/09/80	960	19:10	YOUNG Rick	SZCZEPANIK Russ	N-HABU	2.3
26/09/80	968	13:00	ALISON Tom	VIDA Joe	HABU	2.3
28/09/80	938	10:10	YOUNG Rick	SZCZEPANIK Russ	HABU	2.3
01/10/80	968	10:05	PETERS Dave	BETHART Ed	HABU	4
02/10/80	976	22:35	ALISON Tom	VIDA Joe	N-HABU	2.4
06/10/80	960	15:05	YOUNG Rick	SZCZEPANIK Russ	N-HABU	4.2
10/10/80	976	12:05	PETERS Dave	BETHART Ed	HABU	2.3
14/10/80	980	20:00	ALISON Tom	VIDA Joe	N-HABU	2.4
16/10/80	976	14:02	PETERS Dave	BETHART Ed	HABU	2.3
18/10/80	960	10:40	ALISON Tom	VIDA Joe	HABU	2.3
20/10/80	960	10:15	PETERS Dave	BETHART Ed	HABU	2.4
21/10/80	976	14:50	ALISON Tom	VIDA Joe	HABU	4.3
23/10/80	976		PETERS Dave	BETHART Ed	N-HABU	
25/10/80	976	11:00	PETERS Dave	BETHART Ed	HABU	2.3
28/10/80	960	10:30	CROWDER Bob	MORGAN John	HABU	2.4
29/10/80	976	12:43	JUDSON Rich	KELLY Frank	FCF	4.2
30/10/80	960	20:15	CROWDER Bob	MORGAN John	N-HABU	2.3
31/10/80	958	14:00	JUDSON Rich	KELLY Frank	FCF	3.9
03/11/80	976	13:00	JUDSON Rich	KELLY Frank	HABU	4.2
04/11/80	960	19:50	PETERS Dave	BETHART Ed	N-HABU	2.3
06/11/80	970	11:05	CROWDER Bob	MORGAN John	HABU	4.1
08/11/80	960	12:10	JUDSON Rich	KELLY Frank	HABU	2.3
10/11/80	960	11:15	CROWDER Bob	MORGAN John	HABU	4.3
13/11/80	960	11:15	THOMAS B.C.	REID Jay	HABU	2.5
14/11/80	960	11:15	JUDSON Rich	KELLY Frank	HABU	2.4
17/11/80	970	07:50	CROWDER Bob	MORGAN John	HABU	4.2
18/11/80	960	21:05	THOMAS B.C.	REID Jay	N-HABU	2.3
20/11/80	958	20:30	THOMAS B.C.	REID Jay	N-HABU	2.2
21/11/80	976	12:00	JUDSON Rich	KELLY Frank	FCF	2.5
23/11/80	960	10:25	CROWDER Bob	MORGAN John	HABU	5.7
24/11/80	970	10:10	THOMAS B.C.	REID Jay	HABU-S	5.8
25/11/80	976	21:20	BERTELSON Gil	STAMPF Frank	N-HABU	2.3
26/11/80	958	12:00	CROWDER Bob	MORGAN John	FCF	1.7
28/11/80	938	13:10	THOMAS B.C.	REID Jay	HABU	4.2
01/12/80	958	12:55	BERTELSON Gil	STAMPF Frank	HABU	1.2
02/12/80	958	11:43	CROWDER Bob	MORGAN John	HABU	4.2
03/12/80	976	18:40	THOMAS B.C.	REID Jay	N-HABU	2.3
05/12/80	960	10:35	BERTELSON Gil	STAMPF Frank	HABU	3.8
09/12/80	958	07:51	THOMAS B.C.	REID Jay	HABU	2.3
10/12/80	976	15:10	PETERS Dave	BETHART Ed	HABU	1.9
11/12/80	976	15:10	BERTELSON Gil	STAMPF Frank	HABU	2.3
12/12/80	958	12:08	THOMAS B.C.	REID Jay	HABU	2.3
15/2/80	960	19:30	PETERS Dave	BETHART Ed	N-HABU	2.3
17/12/80	958		BERTELSON Gil	STAMPF Frank	HABU	
18/12/80	958	09:30	BERTELSON Gil	STAMPF Frank	HABU	4.2
19/12/80	960	10:30	BERTELSON Gil	STAMPF Frank	HABU	4.1
21/12/80	976	08:02	BERTELSON Gil	STAMPF Frank	HABU	3.8
23/12/80	960	08:41	CUNNINGHAM Nevin	QUIST Gene	FCF	3.3
27/12/80	976	12:00	CUNNINGHAM Nevin	QUIST Gene	HABU	4.2
29/12/80	958	18:30	CARPENTER Buzz	SHAW Tim	N-HABU	
03/01/81	958	10:40	CUNNINGHAM Nevin	QUIST Gene	HABU	4.1
05/01/81	976	15:17	CARPENTER Buzz	SHAW Tim	HABU	4.2
06/01/81	960	20:15	SHELTON Lee	MacKEAN Barry	N-HABU	2.4
08/01/81	978	10:00	CUNNUNGHAM Nevin	QUIST Gene	HABU	4.3
10/01/81	958	12:00	SHELTON Lee	MacKEAN Barry	HABU	2.2
14/01/81	960	10:00	CARPENTER Buzz	SHAW Tim	HABU	4.1
15/01/80	960	08:05	CARPENTER Buzz	SHAW Tim	RTB FERRY	4.8
15/01/81	976	14:05	CUNNINGHAM Nevin	QUIST Gene	HABU	2.3
19/01/81	976	12:30	SHELTON Lee	MacKEAN Barry	HABU	4.2
20/01/81	958	10:11	CUNNINGHAM Nevin	QUIST Gene	HABU	1.6
21/01/81	960	12:00	CUNNINGHAM Nevin	QUIST Gene	HABU	4.2
22/01/81	960	21:00	ALISON Tom	REID Jay	N-HABU	2.5
26/01/81	958	07:55	SHELTON Lee	MacKEAN Barry	HABU	2.3
28/01/81	960	10:40	CUNNINGHAM Nevin	QUIST Gene	HABU	3.9
29/01/81	970	18:30	ALISON Tom	REID Jay	N-HABU	2.5
30/01/81	958	18:30	ALISON Tom	REID Jay	N-HABU	2.2
02/02/81	958	12:30	SHELTON Lee	MacKEAN Barry	HABU	3.9
04/02/81	976	14:00	YOUNG Rick	SZCZEPANIK Russ	HABU	2.4
06/02/81	958	09:10	ALISON Tom	REID Jay	HABU	4.2
09/02/81	976	10:35	SHELTON Lee	MAcKEAN Barry	HABU	3.9
11/02/81	958	14:55	YOUNG Rick	SZCZEPANIK Russ	HABU	2.3
13/02/81	958	19:55	ALISON Tom	REID Jay	N-HABU	2.4
17/02/81	976	20:15	YOUNG Rick	SZCZEPANIK Russ	N-HABU	2.3

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Hours
19/02/81	958	13:19	ALISON Tom	REID Jay	HABU	3.9
21/02/81	976	10:25	YOUNG Rick	SZCZEPANIK Russ	HABU	4
23/02/81	976	19:30	ALISON Tom	REID Jay	N-HABU	2.3
25/02/81	958	13:45	ALISON Tom	REID Jay	HABU	2.4
27/02/81	958	07:45	YOUNG Rick	SZCZEPANIK Russ	HABU	4.2
02/03/81	976	20:05	PETER Dave	BETHART Ed	N-HABU	2
04/03/81	958	12:05	YOUNG Rick	SZCZEPANIK Russ	HABU	4.3
05/03/81	960	09:30	PETERS Dave	BETHART Ed	FCF	2.2
06/03/81	958	10:30	YOUNG Rick	SZCZEPANIK Russ	HABU	3.9
09/03/81	958	21:00	PETER Dave	BETHART Ed	N-HABU	2.4
11/03/81	960	09:30	YOUNG Rick	SZCZEPANIK Russ	FCF	2.5
12/03/81	976	06:45	JUDSON Rich	KELLY Frank	HABU	4.3
14/03/81	976	12:05	JUDSON Rich	KELLY Frank	HABU	4.3
16/03/81	960	13:00	JUDSON Rich	KELLY Frank	HABU	2.4
17/03/81	958	22:00	JUDSON Rich	KELLY Frank	N-HABU	2.3
20/03/81	960	08:30	PETERS Dave	BETHART Ed	HABU	1.5
21/03/81	960	08:10	JUDSON Rich	KELLY Frank	HABU	3.2
24/03/81	958	10:00	PETERS Dave	BETHART Ed	HABU	4.1
26/03/81	960	11:55	JUDSON Rich	KELLY Frank	HABU	4.2
27/03/81	958	10:30	JUDSON Rich	KELLY Frank	HABU	3.7
01/04/81	958	09:05	CROWDER Bob	MORGAN John	HABU	4
02/04/81	958	20:05	JUDSON Rich	KELLY Frank	N-HABU	2.3
06/04/81	960	07:32	CROWDER Bob	MORGAN John	HABU	4.4
07/04/81	958	10:10	JUDSON Rich	KELLY Frank	HABU	4.1
09/04/81	960	13:45	CROWDER Bob	MORGAN John	HABU	3.7
13/04/81	958	21:02	BERTELSON Gil	STAMPF Frank	N-HABU	2.1
15/04/81	958	12:55	CARPENTER Buzz	SHAW Tim	HABU	4.2
16/04/81	976	09:30	CROWDER Bob	MORGAN John	FCF	2.5
17/04/81	958	08:30	BERTELSON Gil	STAMPF Frank	HABU	4
20/04/81	976	19:45	CARTENTER Buzz	SHAW Tim	N-HABU	2.3
22/04/81	960	14:20	CROWDER Bob	MORGAN John	HABU	4.3
25/04/81	976	09:55	BERTELSON Gil	STAMPF Frank	HABU	2.4
28/04/81	960	12:50	CUNNINGHAM Nevin	QUIST Gene	HABU	2.2
29/04/81	960	12:50	CUNNINGHAM Nevin	QUIST Gene	HABU	4.1
01/05/81	976	10:31	BERTELSON Gil	STAMPF Frank	HABU	2.4
04/05/81	960	20:17	CUNNINGHAM Nevin	QUIST Gene	N-HABU	2.2
06/05/81	976	09:05	CARPENTER Buzz	SHAW Tim	HABU	4
07/05/81	960	13:40	BERTELSON Gil	STAMPF Frank	HABU	4.1
11/05/81	960	19:45	CUNNINGHAM Nevin	QUIST Gene	N-HABU	2.3
13/05/81	960	10:30	CARPENTER Buzz	SHAW Tim	HABU	4
14/05/81	958	09:19	SHELTON Lee	MacKEAN Harry	FCF	3.8
15/05/81	958	10:00	CUNNINGHAM Nevin	QUIST Gene	HABU	4.2
18/05/81	976	11:45	CARPENTER Buzz	SHAW Tim	HABU	4.1
19/05/81	958	20:15	SHELTON Lee	MacKEAN Barry	N-HABU	2.3
22/05/81	960	09:55	CUNNINGHAM Nevin	QUIST Gene	HABU	3.9
26/05/81	976	14:00	SHELTON Lee	MacKEAN Barry	HABU	1.1
27/05/81	976	14:30	SHELTON Lee	MacKEAN Barry	HABU	4.1
29/05/81	958	09:30	ALISON Tom	REID Jay	HABU	5.8
30/05/81	976	16:00	CUNNINGHAM Nevin	QUIST Gene	N-HABU	5.2
02/06/81	958	10:30	SHELTON Lee	MacKEAN Barry	HABU	3.9
04/06/81	960	09:15	ALISON Tom	REID Jay	HABU	2
08/06/81	960	10:00	ALISON Tom	REID Jay	HABU	3.9
09/06/81	976	14:00	SHELTON Lee	MacKEAN Barry	HABU	4.1
11/06/81	958	20:15	YOUNG Rich	SZCZEPANIK Russ	N-HABU	2.3
13/06/81	976	07:50	ALISON Tom	REID Jay	HABU	4.2
15/06/81	958	19:45	SHELTON Lee	MacKEAN Barry	N-HABU	2.2
17/06/81	960	09:15	YOUNG Rich	SZCZEPANIK Russ	HABU	4.1
19/06/81	958	10:35	ALISON Tom	REID Jay	HABU	2.3
22/06/81	958	21:10	ALISON Tom	REID Jay	N-HABU	2.3
25/06/81	958	09:50	BERTELSON Gil	STAMPF Frank	HABU	4.1
25/06/81	960	10:05	GLASSER Jerry	HORNBAKER Mac	FCF	4.2
26/06/81	976	13:00	ALISON Tom	REID Jay	HABU	4.1
29/06/81	976	14:00	GLASSER Jerry	HORNBAKER Mac	HABU	4.1
02/07/81	960	08:00	BERTELSON Gil	STAMPF Frank	HABU	4.1
06/07/81	958	12:05	GLASSER Jerry	HORNBAKER Mac	HABU	4
07/07/81	960	20:30	BERTELSON Gil	STAMPF Frank	N-HABU	2.2
09/07/81	958	10:00	PETERS Dave	BETHART Ed	HABU	4
10/07/81	976	14:20	GLASSER Jerry	HORNBAKER Mac	HABU	4.1
14/07/81	975	03:40	ROSENBERG Maury	McKIM E.D.	FERRY IN-H	6.3
15/07/81	960	05:00	BERTELSON Gil	STAMPF Frank	H-FERRY OUT	
16/07/81	958	05:52	YOUNG Rich	SZCZEPANIK Russ	H-FERRY OUT	
16/07/81	976	05:58	GLASSER Jerry	HORNBAKER Mac	FERRY OUT AIR SPARE	1.2
16/07/81	967	04:19	JUDSON Rich	KELLY Frank	FERRY IN-H	6.7
20/07/81	975	21:00	PETERS Dave	BETHART Ed	N-HABU	2
23/07/81	976	10:00	GLASSER Jerry	HORNBAKER Mac	HABU	1.7

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Length
24/07/81	975	10:00	GLASSER Jerry	HORNBAKER Mac	HABU	3.6
24/07/81	976	12:00	ROSENBERG Maury	McKIM E.D.	FCF	3.9
27/07/81	975	15:25	GLASSER Jerry	HORNBAKER Mac	RTH-FERRY	1.5
27/07/81	976	20:18	PETERS Dave	BETHART Ed	N-HABU	2.3
29/07/81	976	10:15	ROSENBERG Maury	McKIM E.D.	HABU	3.9
31/07/81	976	09:30	PETERS Dave	BETHART Ed	HABU	2.4
03/08/81	975	20:45	JUDSON Rich	KELLY Frank	N-HABU	1
04/08/81	967	11:00	PETERS Dave	BETHART Ed	FCF	2.2
05/08/81	975	09:18	ROSENBERG Maury	McKIM E.D.	HABU	2.1
06/08/81	975	17:00	JUDSON Rich	KELLY Frank	N-HABU	4.1
11/08/81	967	07:40	PETERS Dave	BETHART Ed	HABU	4.2
12/08/81	975	20:48	JUDSON Rich	KELLY Frank	N-HABU	2.3
14/08/81	975	10:15	ROSENBERG Maury	McKIM E.D.	HABU	2.3
15/08/81	967	20:00	JUDSON Rich	KELLY Frank	N-HABU	2.3
17/08/81	975	09:30	CUNNINGHAM Nevin	QUIST Gene	HABU	4.2
18/08/81	976	10:00	ROSENBERG Maury	McKIM E.D.	HABU	4
20/08/81	967	14:00	JUDSON Rich	KELLY Frank	HABU	2.3
24/08/81	975	12:00	CUNNINGHAM Nevin	QUIST Gene	HABU	1
25/08/81	967	10:00	CUNNINGHAM Nevin	QUIST Gene	HABU	4.2
26/08/81	976	13:15	ROSENBERG Maury	McKIM E.D.	HABU	4.1
02/09/81	976		JUDSON Rich	KELLY Frank	HABU	
02/09/81	967	11:00	CROWDER Bob	MORGAN John	HABU	2.4
03/09/81	967	11:45	BERTELSON Gil	STAMPF Frank	HABU	0.9
03/09/81	975	11:00	JUDSON Rich	KELLY Frank	HABU	4
04/09/81	967	09:15	BERTELSON Gil	STAMPF Frank	HABU	3.5
10/09/81	967	12:00	CROWDER Bob	MORGAN John	HABU	2.9
10/09/81	975	04:15	JUDSON Rich	KELLY Frank	N-HABU	2.3
12/09/81	976	09:15	BERTELSON Gil	STAMPF Frank	HABU	2.3
14/09/81	976	18:50	CROWDER Bob	MORGAN John	N-HABU	2.4
16/09/81	976	11:10	CUNNINGHAM Nevin	QUIST Gene	HABU	3.9
18/09/81	976		BERTELSON Gil	STAMPF Frank	HABU	
18/09/81	967		CROWDER Bob	MORGAN John	HABU	
21/09/81	976	19:25	BERTELSON Gil	STAMPF Frank	N-HABU	2.3
24/09/81	967	08:55	CUNNINGHAM Nevin	QUIST Gene	HABU	1.4
24/09/81	976	08:45	CROWDER Bob	MORGAN John	HABU	4.8
28/09/81	975	10:00	BERTELSON Gil	STAMPF Frank	HABU	4.2
29/09/81	976	16:05	CUNNINGHAM Nevin	QUIST Gene	HABU	2.4
02/10/81	967	14:00	THOMAS B.C.	REID Jay	HABU	2.4
03/10/81	975	09:30	CUNNINGHAM Nevin	QUIST Gene	HABU	4
05/10/81	967	13:00	BERTELSON Gil	STAMPF Frank	HABU	3.1
08/10/81	975		THOMAS B.C.	REID Jay	HABU	
09/10/81	967	10:15	THOMAS B.C.	REID Jay	HABU	2.2
14/10/81	975	19:03	CUNNINGHAM Nevin	QUIST Gene	N-HABU	2.3
15/10/81	975	12:20	THOMAS B.C.	REID Jay	HABU	2.3
19/10/81	975	13:05	CUNNINGHAM Nevin	QUIST Gene	HABU	2.3
20/10/81	975	10:00	CUNNINGHAM Nevin	QUIST Gene	HABU	3.9
23/10/81	975	11:00	THOMAS B.C.	REID Jay	HABU	2.5
24/10/81	967	18:30	CUNNINGHAM Nevin	QUIST Gene	N-HABU	3.2
26/10/81	975	08:12	THOMAS B.C.	REID Jay	HABU	4.2
27/10/81	975	08:30	YOUNG Rick	BETHART Ed	HABU	4.2
02/11/81	975	08:00	THOMAS B.C.	REID Jay	HABU	3
03/11/81	975		YOUNG Rick	BETHART Ed	HABU	
03/11/81	967	08:00	THOMAS B.C.	REID Jay	HABU	4.3
04/11/81	976	10:00	McCRARY Rick	LAWRENCE Dave	FCF	4.2
05/11/81	967	08:30	YOUNG Rick	BETHART Ed	HABU	4
09/11/81	976	18:45	YOUNG Rick	BETHART Ed	N-HABU	2.3
12/11/81	967	09:30	McCRARY Rick	LAWRENCE Dave	HABU	4.2
13/11/81	976	10:30	PETERS Dave	SZCZEPANIK Russ	HABU	1.7
15/11/81	976	10:25	PETERS Dave	SZCZEPANIK Russ	RTB FERRY	1.6
16/11/81	967	07:12	YOUNG Rick	BETHART Ed	HABU	4.1
17/11/81	976	07:05	McCRARY Rick	LAWRENCE Dave	HABU	1.8
17/11/81	967	08:01	PETERS Dave	SZCZEPANIK Russ	HABU	4.1
20/11/81	976		McCKARY Rick	LAWRENCE Dave	HABU	
20/11/81	967		PETERS Dave	SZCZEPANIK Russ	HABU	
23/11/81	976	11:45	McCRARY Rick	LAWRENCE Dave	HABU	2.3
24/11/81	967	09:56	PETERS Dave	SZCZEPANIK Russ	HABU	2.5
28/11/81	976	12:30	GLASSER Jerry	HORNBAKER Mac	HABU	2.4
30/11/81	967	08:31	McCRARY Rick	LAWRENCE Dave	HABU	4.2
01/12/81	976	18:15	PETERS Dave	SZCZEPANIK Russ	N-HABU	2.3
03/12/61	967	23:00	GLASSER Jerry	HORNBAKER Mac	N-HABU	2.4
07/12/81	976	10:30	PETERS Dave	SZCZEPANIK Russ	HABU	3.8
08/12/81	967	13:00	ROSENBERG Maury	McKIM E.D.	HABU	4.1

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Leng
09/12/81	975	09:15	GLASSER Jerry	HORNBAKER Mac	FCF	3.8
10/12/81	976	08:57	PETERS Dave	SZCZEPANIK Russ	HABU	4
14/12/81	967	08:30	ROSENBERG Maury	McKIM E.D.	HABU	2.4
15/12/81	976	12:00	GLASSER Jerry	HORNBAKBR Mac	HABU	4.2
17/12/81	975	09:01	ROSENBERG Maury	McKIM E.D.	HABU	3.9
21/12/81	967	09:02	GLASSER Jerry	HORNBAKER Mac	HABU	3.9
23/12/81	975	09:27	CROWDER Bob	MORGAN John	HABU	4
29/12/81	967	10:02	GLASSER Jerry	HORNBAKER Mac	HABU	4
30/12/81	975	18:30	ROSENBERG Maury	McKIM E.D.	N-HABU	2.3
04/01/82	970	07:10	CROWDER Bob	MORGAN John	HABU	3.9
06/01/82	967	10:47	SMITH Bernie	WHALEN Denny	FCF	4.2
07/01/82	975	09:30	ROSENBERG Maury	McKIM E.D.	HABU	4.4
08/01/82	976	12:05	SMITH Bernie	WHALEN Denny	HABU	4.4
12/01/82	975	17:30	ROSENBERG Maury	McKIM E.D.	N-HABU	2.3
14/01/82	967	07:20	CROWDER Bob	MORGAN John	HABU	4
15/01/82	976	09:30	SMITH Bernie	WHALEN Denny	HABU	2.3
16/01/82	967	10:30	CROWDER Bob	MORGAN John	HABU	3.8
18/01/82	975	18:00	JUDSON Rich	KELLY Frank	N-HABU	2.3
20/01/82	976	10:00	SMITH Bernie	WHALEN Denny	HABU	3.9
25/01/82	975	08:15	CROWDER Bob	MORGAN John	HABU	2.4
26/01/82	967	18:25	JUDSON Rich	KELLY Frank	N-HABU	2.3
28/01/82	976	11:00	SMITH Bernie	WHALEN Denny	HABU	1.6
29/01/82	975	09:30	SMITH Bernie	WHALEN Dunny	HABU	3.9
01/02/82	967	10:02	JUDSON Rich	KELLY Frank	N-HABU	4
02/02/82	975	18:45	THOMAS B.C.	REID Jay	N-HABU	2.3
05/02/82	976	10:00	SMITH Bernie	WHALEN Denny	HABU	3.9
08/02/82	975	20:00	JUDSON Rich	KELLY Frank	N-HABU	2.3
10/02/82	967	07:45	THOMAS B.C.	REID Jay	HABU	2.3
12/02/82	976	10:38	JUDSON Rich	KELLY Frank	HABU	1.7
16/02/82	975	19:05	THOMAS B.C.	REID Jay	N-HABU	2.3
19/02/82	975	10:18	JUDSON Rich	KELLY Frank	HABU	4.4
20/02/82	967	10:10	BERTELSON Gil	STAMPF Frank	HABU	2.3
22/02/82	976	08:30	THOMAS B.C.	REID Jay	HABU	4.2
24/02/82	975	09:30	JUDSON Rich	KELLY Frank	HABU	4.3
25/02/82	967	10:15	BERTELSON Gil	STAMPF Frank	HABU	2.4
01/03/82	975	09:05	BERTELSON Gil	STAMPF Frank	HABU	1.7
02/03/82	976	10:01	CUNNINGHAM Nevin	QUIST Gene	HABU	4
04/03/82	975	10:00	SHELTON Lee	KELLER Bill	HABU	4.1
05/03/82	976	12:30	BERTELSON Gil	STAMPF Frank	HABU	4.3
08/03/82	976	18:45	CUNNINGHAM Nevin	QUIST Gene	N-HABU	2.3
10/03/82	976	15:00	SHELTON Lee	KELLER Bill	HABU	2.4
12/03/82	976	11:45	BERTELSON Gil	STAMPF Frank	HABU	2.4
16/03/82	976	14:40	CUNNINGHAM Nevin	QUIST Gene	HABU	4
17/03/82	967	11:46	SHELTON Lee	KELLER Bill	FCF	3
18/03/82	976		BERTELSON Gil	STAMPF Frank	HABU	
20/03/82	975		BERTELSON Gil	STAMPF Frank	HABU	
20/03/82	975	13:15	BERTELSON Gil	STAMPF Frank	HABU	0.4
22/03/82	967	19:00	SHELTON Lee	KELLER Bill	HABU	2.3
24/03/82	976	09:05	BERTELSON Gil	STAMPF Frank	HABU	4
25/03/82	967	10:15	CUNNINGHAM Nevin	QUIST Gene	HABU	4.2
29/03/82	976	06:50	CUNNINGHAM Nevin	QUIST Gene	HABU	2.3
30/03/82	967	20:50	McCRARY Rick	LAWRENCE Dave	N-HABU	2.4
01/01/82	976	09:15	YOUNG Rick	BETHART Ed	HABU	2.8
02/04/82	967	13:00	CUNNINGHAM Nevin	QUIST Gene	HABU	2.4
05/04/82	967	09:20	McCRARY Rick	LAWRENCE Dave	HABU	4.1
06/04/82	976	21:07	CUNNINGHAM Nevin	QUIST Gene	N-HABU	2.2
09/01/82	976	12:10	McCRARY Rick	LAWRENCE Dave	HABU	2.2
12/04/82	967	19:05	YOUNG Rick	BETHART Ed	N-HABU	2.3
14/04/82	976	12:30	McCRARY Rick	LAWRENCE Dave	HABU	4.1
16/04/82	967	10:00	YOUNG Rick	BETHART Ed	HABU	4
19/04/82	976	19:45	YOUNG Rick	BETHART Ed	N-HABU	2.3
22/04/82	967	08:30	McCRARY Rick	LAWRENCE Dave	HABU	4.2
27/04/82	967	11:00	McCKARY Rick	LAWRENCE Dave	HABU	4.3
29/04/82	976	10:30	CROWDER Bob	MORGAN John	HABU	4.1
03/05/82	970	11:15	CROWDER Bob	MORGAN John	HABU	4.2
04/05/82	967	19:30	McCRARY Rick	LAWRENCE Dave	N-HABU	2.3
05/05/82	975	?	CROWDER Bob	MORGAN John	FCF	4.2
07/05/82	976	10:30	McCRARY Rick	LAWRENCE Dave	HABU	2.3
08/05/82	967	10:00	CROWDER Bob	LAWRENCE Dave	FCF	2.7
10/05/82	976	09:35	GLASSER Jerry	HORNBAKER Mac	HABU	4
12/05/82	976	20:03	GLASSOR Jerry	HORNBAKER Mac	N-HABU	2.4
13/05/82	975	14:00	CROWDER Bob	HORNBAKER Mac	FCF	2.4
17/05/82	976	20:05	CROWDER Bob	MORGAN John	N-HABU	2.2
19/05/82	967	09:20	GLASSER Jerry	HORNBAKER Mac	HABU	4.3
20/05/82	967	11:00	CROWDER Bob	MORGAN John	HABU	1.7
22/05/82	967		CROWDER Bob	MORGAN John	RTB FERRY	

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Length
24/05/82	976	09:30	GLASSER Jerry	HORNBAKER Mac	HABU	3.6
26/05/82	975	08:00	ROSENBERG Maury	McKIM E.D.	HABU	2.4
27/05/82	976	10:15	GLASSER Jerry	HORNBAKER Mac	HABU	4.1
28/05/82	975	12:10	ROSENBERG Maury	McKIM E.D.	HABU	1.6
29/05/82	975	14:00	ROSENBERG Maury	McKIM E.D.	HABU	2.2
31/05/82	975	11:00	GLASSER Jerry	HORNBAKER Mac	HABU	2.3
01/06/82	976	20:15	ROSENBERG Maury	McKIM E.D.	N-HABU	2.2
03/06/82	975	15:00	GLASSER Jerry	HORNBAKER Mac	HABU	2.2
06/06/82	980	04:25	SHELTON Lee	SZCZEPANIK Russ	FERRY IN	5.9
07/06/82	976	6:00	CROWDER Bob	MORGAN John	FERRY OUT	
09/06/82	975	09:05	GLASSER Jerry	HORNBAKER Mac	HABU	3.8
11/06/82	980	08:40	SHELTON Lee	SZCZEPANIK Russ	HABU	2.4
15/06/82	980	08:22	GLASSER Jerry	HORNBAKER Mac	HABU	4
16/06/82	967	09:50	SHELTON Lee	SZCZEPANIK Russ	KTB FERRY	1.9
17/06/82	980	12:00	LULOFF Gil	COATS Bob	FCF	4.1
17/06/82	975	16:45	SHELTON Lee	SZCZEPANIK Russ	FCF	2
18/06/82	975	12:51	LULOFF Gil	COATS Bob	HABU	2.3
19/06/82	975	10:00	LULOFF Gil	COATS Bob	HABU	2.4
22/06/82	975	09:31	SHELTON Lee	SZCZEPANIK Russ	HABU	2.6
23/06/82	980	21:00	SMITH Bernie	WHALEN Denny	N-HABU	2.2
24/06/82	967		SHELTON Lee	SZCZEPANIK Russ	FCP	
24/06/82	967	14:01	SHELTON Lee	SZCZEPANIK Russ	FCF	1.7
25/06/82	975		LULOFF Gil	COATS Bob	HABU	
25/06/82	975	12:00	LULOFF Gil	COATS Bob	HABU	4
26/06/82	980	11:00	SMITH Bernie	WHALEN Denny	HABU	2.3
26/06/82	967	15:00	SHELTON Lee	SZCZEPANIK Russ	FCF	2.2
28/06/82	980	19:30	SHELTON Lee	SZCZEPANIK Russ	N-HABU	2.3
30/06/82	967	06:00	SMITH Bernie	WHALEN Denny	FERRY OUT	
02/07/82	980	11:00	LULOFF Gil	COATS Bob	HABU	2.3
06/07/82	975	10:15	SHELTON Lee	SZCZEPANIK Russ	HABU	4.1
07/07/82	980	19:45	SHELTON Lee	SZCZEPANIK Russ	N-HABU	2.4
09/07/82	980	09:45	LULOFF Gil	COATS Bob	HABU	4.2
13/07/82	975	10:35	SHELTON Lee	SZCZEPANIK Russ	HABU	2.6
13/07/82	980	09:40	LULOFF Gil	COATS Bob	HABU	3.8
15/07/82	975	10:00	JUDSON Rich	HORNBAKER Mac	HABU	4
19/07/82	975	20:09	LULOFF Gil	COATS Bob	N-HABU	2.2
21/07/82	980	13:15	JUDSON Rich	HORNBAKER Mac	HABU	4.1
23/07/82	975	09:30	LULOFF Gil	COATS Bob	HABU	2.3
27/07/82	980	20:45	LULOFF Gil	COATS Bob	N-HABU	2.3
29/07/82	975	10:15	JUDSON Rich	HORNBAKER Mac	HABU	2.3
02/08/82	980	10:06	JUDSON Rich	HOHNBAKER Mac	HABU	4.2
03/08/82	975	20:05	SMITH Bernie	WHALEN Denny	N-HABU	2.3
05/08/82	980	10:22	JUDSON Rich	HORNBAKER Mac	HABU	4.1
12/08/82	975	11:09	SMITH Bernie	WHALEN Denny	HABU	2.4
13/08/82	980	11:00	JUSDON Rich	HORNBAKER Mac	HABU	4
19/08/82	975	08:00	SMITH Bernie	WHALEN Denny	HABU	2.3
21/08/62	975	10:00	JUDSON Rich	HORNBAKER Mac	HABU	1.8
23/08/82	975	12:00	SMITH Bernie	WHALEN Denny	HABU	3.7
27/08/82	975	11:30	SMITH Bernie	WHALEN Denny	HABU	2.4
28/08/82	975	13:00	SMITH Bernie	WHALEN Denny	HABU	2.3
30/08/82	975		SMITH Bernie	WHALEN Denny	HABU	
31/08/82	975	18:45	SMITH Bernie	WHALEN Denny	N-HABU	2.3
01/09/82	975	12:00	BERTELSON Gil	STAMPF Frank	HABU	3.9
02/09/82	980	19:15	SMITH Bernie	WHALEN Denny	N-HABU	2.3
06/09/82	975	11:00	BERTELSON Gil	STAMPF Frank	HABU	3.8
08/09/82	980	20:30	SMITH Bernie	WHALEN Denny	N-HABU	2.5
10/09/82	980	09:45	BERTELSON Gil	STAMPF Frank	HABU	2.3
14/09/82	980	08:30	BERTELSON Gil	STAMPF Frank	HABU	4
15/09/82	980	11:30	DYER Les	GREENWOOD Dan	FCF	4.1
17/09/82	980	10:00	DYER Les	GREENWOOD Dan	HABU	4.1
20/09/82	980	10:30	BERTELSON Gil	STAMPF Frank	HABU	3.9
22/09/82	980	10:45	DYER Les	GREENWOOD Dan	HABU	3.8
23/09/82	975	07:57	BERTELSON Gil	STAMPF Frank	FCF	1.1
24/09/82	980	14:02	DYER Les	GREENWOOD Dan	HABU	2.3
27/09/82	975	20:07	BERTELSON Gil	STAMPF Frank	N-HABU	2.3
29/09/82	980	11:30	DYER Les	GREENWOOD Dan	HABU	4
02/10/82	975	10:30	BERTELSON Gil	STAMPF Frank	HABU	3.8
04/10/82	975	12:25	BERTELSON Gil	STAMPF Frank	HABU	3.8
08/10/82	980	08:00	CUNNINGHAM Nevin	QUIST Gene	HABU	4.6
08/10/82	975	08:46	DYER Les	GREENWOOD Dan	HABU	5.5
12/10/82	975	10:04	CUNNINGHAM Nevin	QUIST Gene	HABU	2.3
13/10/82	980	19:30	DYER Les	GREENWOOD Dan	N-HABU	2.2
15/10/82	975	09:30	CUNNINGHAM Nevin	QUIST Gene	HABU	0.5
15/10/82	975	14:00	CUNNINGHAM Nevin	QUIST Gene	HABU	2.3
18/10/82	980	12:30	DYER Les	GREENWOOD Dan	HABU	4.1
19/10/82	975	20:15	CUNNINGHAM Nevin	QUIST Gene	N-HABU	2.2
22/10/82	980	11:00	DYER Les	GREENWOOD Dan	HABU	4
26/10/82	980	10:45	DYER Les	GREENWOOD Dan	HABU	2.2

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Length
28/10/82	975	10:00	CUNNINGHAM Nevin	QUIST Gene	HABU	2.6
30/10/82	980	08:45	CUNNINGHAM Nevin	QUIST Gene	HABU	5.4
02/11/82	980	21:30	McCRARY Rick	WHALEN Denny	N-HABU	2.3
04/11/82	975	10:36	CUNNINGHAM Nevin	QUIST Gene	HABU	3.7
06/11/82	980		McCRARY Rick	WHALEN Denny	HABU	
06/11/82	980	11:04	McCRARY Rick	WHALEN Denny	HABU	2.2
08/11/82	975	09:30	McCRARY Rick	WHALEN Denny	HABU	2.2
12/11/82	960	04:15	ROSENBERG Maury	BETHART Ed	FERRY IN-H	6.2
13/11/82	980	08:12	CUNNINGHAM Nevin	QUIST Gene	H-FERRY OUT	
15/11/82	975	14:58	McCRARY Rick	WHALEN Denny	HABU	2.2
17/11/82	900	09:15	McCRARY Rick	WHALEN Denny	HABU	2.3
18/11/82	960	09:45	ROSENBERG Maury	BETHART Ed	HABU	2.3
24/11/82	975	10:30	ROSENBERG Maury	BETHART Ed	HABU	3.8
26/11/82	960	11:00	BURK Bill	HENICHEK Tom	FCF	2.5
27/11/82	975	09:45	BURK Bill	HENICHEK Tom	HABU	2.8
10/11/82	960	12:15	ROSENBERG Maury	BETHART Ed	HABU	2.3
01/12/82	960	10:00	BURK Bill	HENICHEK Tom	HABU	3.9
03/12/82	960	10:00	ROSENBERG Maury	BETHART Ed	HABU	2.3
06/12/82	975	10:03	BURK Bill	HENICHEK Tom	HABU	2.5
08/12/82	960	10:00	BURK Bill	HENICHEK Tom	HABU	3.6
09/12/82	975	09:05	BURK Bill	HENICHEK Tom	HABU	2.3
14/12/82	975	13:00	ROSENBERG Maury	BETHART Ed	HABU	2.3
16/12/82	960	10:30	BURK Bill	HENICHEK Tom	HABU	3.2
18/12/82	975	11:00	ROSENBERG Maury	BETHART Ed	HABU	3.6
20/12/82	960	18:00	BURK Bill	HENICHEK Tom	N-HABU	2.3
22/12/82	975	14:00	ROSENBERG Maury	BETHART Ed	HABU	2.3
27/12/82	960	18:30	ROSENBERG Maury	BETHART Ed	N-HABU	2.3
29/12/82	975	10:00	BURK Bill	HENICHEK Tom	HABU	2.3
05/01/83	960		SHELTON Lee	MORGAN John	HABU	
06/01/83	975	19:00	SHELTON Lee	MORGAN John	HABU	2.5
08/01/83	960	10:43	GLASSER Jerry	LAWRENCE Dave	HABU	2.3
10/01/83	975	10:30	SHELTON Lee	MORGAN John	HABU	3.7
12/01/83	960	11:30	GLASSER Jerry	LAWRENCE Dave	HABU	2.4
14/01/83	975	08:00	SHELTON Lee	MORGAN John	HABU	2.4
17/01/83	960	11:00	GLASSER Jerry	LAWRENCE Dave	HABU	2.8
18/01/83	975	14:00	SHELTON Lee	MORGAN John	HABU	2.4
20/01/83	975	09:30	GLASSER Jerry	MORGAN John	HABU	2.3
21/01/83	960	10:30	SHELTON Lee	MORGAN John	HABU	2.4
23/01/83	960	09:05	GLASSER Jerry	LAWRENCE Dave	HABU	2.8
26/01/83	975	18:45	GLASSER Jerry	LAWRENCE Dave	N-HABU	1.7
27/01/83	960	18:45	GLASSER Jerry	LAWRENCE Dave	N-HABU	2.3
28/01/83	960	18:45	LULOFF Gil	COATS Bob	HABU	2.4
01/02/83	975	09:45	GLASSER Jerry	LAWRENCE Dave	HABU	4.1
03/02/83	975	21:00	LULOFF Gil	COATS Bob	N-HABU	2.3
04/02/83	960	12:13	GLASSER Jerry	LAWRENCE Dave	HABU	2.3
07/02/83	975	11:30	LULOFF Gil	COATS Bob	HABU	2.3
12/02/83	960		LULOFF Gil	COATS Bob	HABU	
13/02/83	975	11:00	GLASSER Jerry	LAWRENCE Dave	HABU	2.3
14/02/83	975	10:00	LULOFF Gil	COATS Bob	HABU	2.4
15/02/83	964	04:00	JUDSON Rich	HORNBAKER Mac	FERRY IN-H	6.2
17/02/83	975	08:00	GLASSER Jerry	LAWRENCE Dave	H-FERRY OUT	
18/02/83	960	10:00	JUDSON Rich	HORNBAKER Mac	HABU	4
22/02/83	960	18:45	LULOFF Gil	COATS Bob	N-HABU	2.4
24/02/83	964	09:30	JUDSON Rich	HORNBAKER Mac	HABU	2.3
25/02/83	960	10:00	LULOFF Gil	COATS Bob	HABU	4.1
01/03/83	964	20:30	LULOFF Gil	COATS Bob	N-HABU	2.3
03/03/83	960	08:30	JUDSON Rich	HORNBAKER Mac	HABU	2.2
07/03/83	960	09:30	JUDSON Rich	HORNBAKER Mac	HABU	3.5
09/03/83	960	09:30	SMITH Bernie	McKIM E.D.	HABU	2.3
11/03/83	964	11:30	JUDSON Rich	HORNBAKER Mac	HABU	3.8
15/03/83	964	06:00	SMITH Bernie	McKIM E.D.	HABU	2.3
16/03/83	960	13:00	JUDSON Rich	HORNBAKER Mac	HABU	2.5
18/03/83	964	10:00	SMITH Bernie	McKIM E.D.	HABU	4
21/03/83	960	20:00	JUDSON Rich	HORNBAKER Mac	N-HABU	2.3
23/03/83	960	08:20	JUDSON Rich	HORNBAKER Mac	HABU	4.2
24/03/83	960	09:05	SMITH Bernie	McKIM E.D.	HABU	2.8
25/03/83	964	19:30	SMITH Bernie	McKIM E.D.	N-HABU	2.3
30/03/83	960	10:30	JIGGENS Jim	McCUE Joe	FCF	4.2
01/04/83	960	09:15	JIGGENS Jim	McCUE Joe	HABU	2.4
04/04/83	964	18:45	SMITH Bernie	McCUE E.D.	HABU	2.3
06/04/83	960	10:15	JIGGENS Jim	McCUE Joe	HABU	4.2
08/04/83	964	09:10	SMITH Bernie	McCUE E.D.	HABU	2.7
11/04/83	960	10:00	JIGGENS Jim	McCUE Joe	HABU	2.3
12/04/83	960	13:15	SMITH Bernie	McCUE E.D.	HABU	4
14/04/83	960	09:05	JIGGENS Jim	McCUE Joe	HABU	2.4
18/04/83	964	19:15	PETERS Dave	KELLER Bill	N-HABU	1.3
19/04/83	964	19:15	PETERS Dave	KELLER Bill	N-HABU	2.5
21/04/83	964	10:30	JIGGENS Jim	McCUE Joe	HABU	3
22/04/83	960	12:14	PETERS Dave	KELLER Bill	HABU	2.2
26/04/83	964	21:00	JIGGENS Jim	McCUE Joe	N-HABU	2.3
28/04/83	964	11:30	PETERS Dave	KELLER Bill	HABU	4

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Length
02/05/83	964	10:17	PETERS Dave	KELLER Bill	HABU	4.1
03/05/83	960	19:00	JIGGENS Jim	McCUE Joe	N-HABU	1.9
05/05/83	964	09:05	PETERS Dave	KELLER Bill	HABU	2.4
09/05/83	960	08:15	PETERS Dave	KELLER Bill	HABU	2.2
11/05/83	964	08:30	BEHLER Bob	TABOR Ron	FCF	4.1
12/05/83	964	13:00	BEHLER Bob	TABOR Ron	HABU	4.1
13/05/83	960	13:30	PETERS Dave	KELLER Bill	HABU	2.5
16/05/83	964	11:30	BEHLER Bob	TABOR Ron	HABU	3.8
18/05/83	960	20:58	PETERS Dave	KELLER Bill	N-HABU	2.3
20/05/83	964	10:08	BEHLER Bob	TABOR Ron	HABU	3.9
24/05/83	964	19:35	PETERS Dave	KELLER Bill	N-HABU	2.3
25/05/83	960	12:30	BEHLER Bob	TABOR Ron	HABU	2.3
27/05/83	964	10:00	BEHLER Bob	TABOR Ron	HABU	1.8
01/06/83	964	09:15	McCRARY Rick	LAWRENCE Dave	HABU	4.1
02/06/83	960	20:55	BEHLER Bob	TABOR Ron	N-HABU	2.2
06/06/83	964	08:30	McCRARY Rick	LAWRENCE Dave	HABU	3.8
07/06/83	960	14:00	BEHLER Bob	TABOR Ron	HABU	2.2
10/06/83	964	11:00	McCRARY Rick	LAWRENCE Dave	HABU	3.9
13/06/83	960	12:30	BEHLER Bob	TABOR Ron	HABU	2.2
14/06/83	964	19:30	BEHLER Bob	TABOR Ron	N-HABU	2.3
16/06/83	964	09:05	McCRARY Rick	LAWRENCE Dave	HABU	2.4
20/06/83	964	20:00	McCRARY Rick	LAWRENCE Dave	N-HABU	2.2
22/06/83	960	10:00	BURK Bill	HENICHEK Tom	HABU	2.2
27/06/83	964	05:00	BURK Bill	HENICHEK Tom	HABU	4.9
27/06/83	960	05:30	McCRARY Rick	LAWRENCE Dave	HABU	3.9
01/07/83	960	09:15	McCRARY Rick	LAWRENCE Dave	HABU	4.1
05/07/83	964	19:50	BURK Bill	HENICHEK Tom	N-HABU	2.5
07/07/83	964	09:30	McCRARY Rick	LAWRENCE Dave	HABU	2.3
11/07/83	964	12:00	BURK Bill	HENICHEK Tom	HABU	3.9
14/07/83	964	08:30	CUNNINGHAM Nevin	QUIST Gene	HABU	2.3
15/07/83	964	12:00	BURK Bill	HENICHEK Tom	HABU	3.7
18/07/83	964	11:10	CUNNINGHAM Nevin	QUIST Gene	HABU	2.3
20/07/83	964	10:04	BURK Bill	HENICHEK Tom	HABU	4.2
21/07/83	964	20:00	CUNNINGHAM Nevin	QUIST Gene	N-HABU	2.3
22/07/83	960	14:00	BURK Bill	HENICHEK Tom	FCF	4.1
25/07/83	960	10:30	CUNNINGHAM Nevin	QUIST Gene	HABU	3.9
26/07/83	960	19:45	BURK Bill	HENICHEK Tom	N-HABU	1.4
27/07/83	960	24:00	BURK Bill	HENICHEK Tom	N-HABU	2.2
28/07/83	960	09:45	CUNNINGHAM Nevin	QUIST Gene	HABU	2.2
01/08/83	964	12:15	CUNNINGHAM Nevin	QUIST Gene	HABU	4.1
03/08/83	960	11:48	BOUDREAUX Stormy	NEWGREEN Terry	FCF	4.2
04/08/83	960	19:15	CUNNINGHAM Nevin	QUIST Gene	N-HABU	2.3
06/08/83	964	12:00	BOUDREAUX Stormy	NEWGREEN Terry	HABU	3.7
10/08/83	964	08:10	CUNNINGHAM Nevin	QUIST Gene	HABU	2.2
16/08/83	960	19:30	CUNNINGHAM Nevin	QUIST Gene	N-HABU	2.4
18/08/83	964	09:15	BOUDREAUX Stormy	NEWGREEN Terry	HABU	2.3
20/08/83	964	12:13	BOUDREAUX Stormy	NEWGREEN Terry	HABU	2.3
23/08/83	964	10:30	BOUDREAUX Stormy	NEWGREEN Terry	HABU	2.3
24/08/83	960	20:00	DYER Les	WHALEN Denny	N-HABU	2.4
27/08/83	960	13:15	BOUDREAUX Stormy	NEWGREEN Terry	HABU	4.3
29/08/83	960	09:45	DYER Les	WHALEN Denny	HABU	3.9
30/08/83	964	10:15	BOUDREAUX Stormy	NEWGREEN Terry	HABU	2.4
01/09/83	964	09:05	DYER Les	WHALEN Denny	HABU	2.2
02/09/83	960	12:00	BOUDREAUX Stormy	NEWGREEN Terry	HABU	2.3
06/09/83	960	11:00	DYER Les	WHALEN Denny	HABU	0.9
06/09/83	960	14:15	DYER Les	WHALEN Denny	HABU	3.9
08/09/83	960	09:30	DYER Les	WHALEN Denny	HABU	2.2
12/09/83	960	18:45	ROSENBERG Maury	McKIM E.D.	HABU	1.2
14/09/83	960	08:30	ROSENBERG Maury	McKIM E.D.	HABU	4
16/09/83	960	10:15	DYER Les	GREENWOOD Dan	HABU	1.7
19/09/83	960	13:00	DYER Les	GREENWOOD Dan	HABU	3.8
20/09/83	960	19:35	ROSENBERG Maury	McKIM E.D.	N-HABU	2.2
22/09/83	960	13:00	DYER Les	GREENWOOD Dan	HABU	4.4
23/09/83	964	13:00	ROSENBERG Maury	McKIM E.D.	FCF	2.3
24/09/83	960	09:45	DYER Les	GREENWOOD Dan	HABU	4.1
29/09/83	964	10:00	ROSENBERG Maury	McKIM E.D.	HABU	2.3

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Leng
01/10/83	964	10:04	ROSENBERG Maury	McKIM E.D.	HABU	2.2
03/10/83	964	18:45	LULOFF Gil	COATS Bob	N-HABU	2.3
05/10/83	964	12:00	ROSENBERG Maury	McKIM E.D.	HABU	4.1
06/10/83	960		LULOFF Gil	COATS Bob	HABU	
06/10/83	960	14:16	LULOFF Gil	COATS Bob	HABU	3.6
11/10/83	964	18:30	ROSENBERG Maury	McKIM E.D.	N-HABU	2.3
14/10/83	960	09:45	LULOFF Gil	COATS Bob	HABU	2.4
17/10/83	960	10:04	ROSENBERG Maury	McKIM E.D.	HABU	4.1
18/10/83	960	09:30	LULOFF Gil	COATS Bob	HABU	2.4
20/10/83	964	09:05	LULOFF Gil	COATS Bob	HABU	2.3
24/10/83	960	10:30	LULOFF Gil	COATS Bob	HABU	3.3
25/10/83	964	10:30	LULOFF Gil	COATS Bob	HABU	3.7
26/10/83	960	20:00	THOMAS B.C	MORGAN John	N-HABU	2.3
28/10/83	960	11:03	LULOFF Gil	COATS Bob	HABU	3.8
01/11/83	964	18:00	THOMAS B.C	MORGAN John	N-HABU	2.5
03/11/83	960	11:20	LULOFF Gil	COATS Bob	HABU	4.1
04/11/83	960	09:45	THOMAS B.C	MORGAN John	HABU	2.4
07/11/83	964	10:30	LULOFF Gil	COATS Bob	HABU	3.9
08/11/83	960	11:00	THOMAS B.C	MORGAN John	HABU	4.1
10/11/83	964	09:05	THOMAS B.C	MORGAN John	HABU	2.4
14/11/83	960	18:15	LULOFF Gil	COATS Bob	N-HABU	2.4
16/11/83	964	09:30	THOMAS B.C	MORGAN John	HABU	2.4
19/11/83	976	05:00	GLASSER Jerry	ROSS Ted	FERRY IN-H	6.6
20/11/83	960	08:00	LULOFF Gil	COATS Bob	FERRY OUT	
23/11/83	964	07:15	THOMAS B.C	MORGAN John	HABU	4
28/11/83	964	21:08	GLASSER Jerry	ROSS Ted	N-HABU	2.4
01/12/83	976		GLASSER Jerry	ROSS Ted	HABU	
01/12/83	976	11:20	GLASSER Jerry	ROSS Ted	HABU	2.4
05/12/83	964	18:00	GLASSER Jerry	ROSS Ted	N-HABU	2.3
07/12/83	976	14:00	BEHLER Bob	TABOR Ron	HABU	2.3
09/12/83	964	09:45	GLASSER Jerry	ROSS Ted	N-HABU	3.8
12/12/83	964	12:00	BEHLER Bob	TABOR Ron	HABU	3.8
14/12/83	976	09:05	GLASSER Jerry	ROSS Ted	HABU	3.9
15/12/83	976		BEHLER Bob	TABOR Ron	HABU	
15/12/83	964	21:46	BEHLER Bob	TABOR Ron	N-HABU	2.2
19/12/83	964	17:45	GLASSER Jerry	ROSS Ted	N-HABU	2.4
20/12/83	976	13:00	BEHLER Bob	TABOR Ron	HABU	2.3
22/12/83	976	09:15	BEHLER Bob	TABOR Ron	HABU	2.3
27/12/83	964	10:00	SMITH Bernie	WHALEN Denny	HABU	4
29/12/83	976	12:00	BEHLER Bob	TABOR Ron	HABU	3
03/01/84	964	11:15	SMITH Bernie	WHALEN Denny	HABU	1.5
03/01/84	964	16:15	SMITH Bernie	WHALEN Denny	HABU	2.3
05/01/84	964	09:45	BEHLER Bob	TABOR Ron	HABU	2.3
06/01/84	964	10:00	SMITH Bernie	WHALEN Dennis	HABU	3.8
09/01/84	976	18:00	BEHLER Bob	TABOR Ron	N-HABU	2.3
11/01/84	976	09:30	SMITH Bernie	WHALEN Dennis	HABU	2.3
12/01/84	976	09:30	SMITH Bernie	WHALEN Dennis	HABU	2.3
17/01/84	964	11:00	MATTHEWS Joe	OSTERHELD Curt	FCF	2.7
17/01/84	976	18:00	SMITH Bernie	WHALEN Dennis	N-HABU	2.2
19/01/84	964	11:00	MATTHEWS Joe	OSTERHELD Curt	HABU	0.8
20/01/84	964	10:00	MATTHEWS Joe	OSTERHELD Curt	HABU	4.3
23/01/84	976	13:00	MATTHEWS Joe	OSTERHELD Curt	HABU	1.5
25/01/84	964	18:15	SMITH Bernie	WHALEN DENNIS	N-HABU	2.2
25/01/84	976	12:14	MATTHEWS Joe	OSTERHELD Curt	RTH FERRY	1.5
27/01/84	964	10:00	MATTHEWS Joe	OSTERHELD Curt	HABU	3.9
30/01/84	976	10:15	SMITH Bernie	WHALEN Dennis	N-HABU	2.3
01/02/84	964	10:00	MATTHEWS Joe	OSTERHELD Curt	HABU	2.3
02/02/84	976	10:55	MATTHEWS Joe	OSTERHELD Curt	HABU	2.3
06/02/84	976	18:08	MATTHEWS Joe	OSTERHELD Curt	HABU	2.3
08/02/84	976	10:30	PETERS Dave	BETHART Ed	HABU	2
10/02/84	964	12:02	MATTHEWS Joe	OSTERHELD Curt	HABU	2.5
14/02/84	976	12:15	PETERS Dave	BETHART Ed	HABU	2.3
15/02/84	964	18:45	MATTHEWS Joe	OSTERHELD Curt	N-HABU	2.3
17/02/84	976	10:02	PETERS Dave	BETHART Ed	HABU	3.7
21/02/84	964	18:05	MATTHEWS Joe	OSTERHELD Curt	N-HABU	2.3
23/02/84	976	09:30	PETERS Dave	BETHART Ed	HABU	2.3
27/02/84	964	10:00	PETERS Dave	BETHART Ed	HABU	3.8
28/02/84	964	13:00	JIGGENS Jim	McCUE Joe	HABU	2.9
03/03/84	976	10:00	PETERS Dave	BETHART Ed	HABU	3.8
05/03/84	964	18:45	JIGGENS Jim	McCUE JOE	N-HABU	2.3
07/03/84	964	11:00	PETERS Dave	BETHART Ed	HABU	2.3
09/03/84	964	10:00	JIGGENS Jim	McCUE Joe	HABU	2.2
12/03/84	964	19:00	PETERS Dave	BETHART Ed	N-HABU	2.4
13/02/84	976	14:00	JIGGENS Jim	McCUE Joe	HABU	2.4
15/03/84	976	09:30	JIGGENS Jim	McCUE Joe	HABU	2.3
20/03/84	964	19:15	BOUDREAUX Stormy	NEWGREEN Terry	N-HABU	2.3
23/03/84	964	11:00	JIGGENS Jim	McCUE Joe	HABU	2.3
27/03/84	964	09:02	BOUDREAUX Stormy	NEWGREEN Terry	HABU	2.3
27/03/84	973	04:45	DYER Les	GREENWOOD Dan	FERRY IN-H	6.7
29/03/84	964		JIGGENS Jim	McCUE Joe	HABU	
30/03/84	964	08:10	JIGGENS Jim	McCUE Joe	H-FERRY OUT	

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Length
02/04/84	976	09:45	BOUDREAUX Stormy	NEWGREEN Terry	HABU	2.3
03/04/84	976	14:00	DYER Les	GREENWOOD Dan	HABU	2.1
05/04/84	973	09:15	BOUDREAUX Stormy	NEWGREEN Terry	HABU	2.4
09/04/84	976	10:15	DYER Les	GREENWOOD Dan	HABU	2.2
11/04/84	973	19:05	BOUDREAUX Stormy	NEWGREEN Terry	N-HABU	2.3
13/04/84	973	09:05	DYER Les	GREENWOOD Dan	HABU	2.2
16/04/84	973	19:00	BOUDREAUX Stormy	NEWGREEN Terry	N-HABU	2.3
18/04/84	973	14:30	DYER Les	GREENWOOD Dan	HABU	2.2
20/04/84	976	09:30	BOUDREAUX Stormy	NEWGREEN Terry	HABU	2.2
23/04/84	973	13:00	DYER Les	GREENWOOD Dan	HABU	2.3
24/04/84	976	19:15	BOUDREAUX Stormy	NEWGREEN Terry	N-HABU	2.3
29/04/84	973	10:00	DYER Les	GREENWOOD Dan	HABU	2.3
01/05/84	976	16:00	CUNNINGHAM Nevin	QUIST Gene	HABU	3.4
02/05/84	976	12:00	CUNNINGHAM Nevin	QUIST Gene	HABU	2.3
03/05/84	976	09:30	DYER Les	GREENWOOD Dan	HABU	2.2
08/05/84	976		CUNNINGHAM Nevin	QUIST Gene	HABU	
08/05/84	976	10:35	CUNNINGHAM Nevin	QUIST Gene	HABU	3.7
09/05/84	973	21:00	DYER Les	GREENWOOD Gene	N-HABU	2.2
11/05/84	976	06:00	CUNNINGHAM Nevin	QUIST Gene	HABU	2.3
14/05/84	976	21:21	DYER Les	GREENWOOD Dan	N-HABU	2.1
16/05/84	973	09:47	DYER Les	GREENWOOD Dan	HABU	2.3
17/05/84	976	09:30	CUNNINGHAM Nevin	QUIST Gene	HABU	2.4
21/05/84	976	17:30	CUNNINGHAM Nevin	QUIST Gene	N-HABU	2.1
23/05/84	973	22:00	BURK Bill	HENICHEK Tom	N-HABU	2.3
25/05/84	976		CUNNINGHAM Nevin	QUIST Gene	HABU	
25/05/84	976	11:15	CUNNINGHAM Nevin	QUIST Gene	HABU	2.4
29/05/84	976	18:00	BURK Bill	HENICHEK Tom	HABU	2.2
30/05/84	976	12:30	CUNNINGHAM Nevin	QUIST Gene	HABU	2.2
01/06/84	976	13:00	BURK Bill	HENICHEK Tom	HABU	2.4
04/06/84	976	20:00	CUNNINGHAM Nevin	QUIST Gene	N-HABU	2.5
06/06/84	973	07:30	BURK Bill	HENICHEK Tom	HABU	2.4
07/06/84	976	09:15	BURK Bill	HENICHEK Tom	HABU	2.2
11/06/84	973	16:30	PETERS Dave	BETHART Ed	HABU	2.2
13/06/84	973	20:30	BURK Bill	HENICHEK Tom	N-HABU	2.2
15/06/84	973	08:15	PETERS Dave	BETHART Ed	HABU	1.6
18/06/84	973	16:50	BURK Bill	HENICHEK Tom	HABU	2.1
21/06/84	976	14:22	PETERS Dave	BETHART Ed	FCF	0.9
22/06/84	973	19:30	BURK Bill	HENICHEK Tom	N-HABU	2.3
25/06/84	976	11:25	BURK Bill	HENICHEK Tom	FCF	2.6
27/06/84	976	07:50	PETERS Dave	BETHART Ed	HABU	3.8
28/06/84	973	09:30	BURK Bill	HENICHEK Tom	HABU	1.7
29/06/84	973	11:00	PETERS Dave	BETHART Ed	HABU	2.3
02/07/84	973	19:45	PETERS Dave	BETHART Ed	N-HABU	2.2
05/07/84	973	13:15	MADISON Jack	ORCUTT Bill	FCF	2.5
06/07/84	973	09:15	MADISON Jack	ORCUTT Bill	HABU	2.4
09/07/84	973		PETERS Dave	BETHART Ed	N-HABU	
10/07/84	976	19:30	PETERS Dave	BETHART Ed	N-HABU	2.3
12/07/84	976	09:58	MADISON Jack	ORCUTT Bill	HABU	2.2
13/07/84	976	09:45	PETERS Dave	BETHART Ed	HABU	2.4
16/07/84	976	16:41	MADISON Jack	ORCUTT Bill	HABU	2.2
18/07/84	976	14:00	PETERS Dave	BETHART Ed	HABU	2.2
20/07/84	976	12:32	MADISON Jack	ORCUTT Bill	HABU	3.8
21/07/84	976		MADISON Jack	ORCUTT Bill	HABU	
24/07/84	976	20:00	LULOFF Gil	COATS Bob	N-HABU	2.3
26/07/84	976	09:30	MADISON Jack	ORCUTT Bill	HABU	2.4
27/07/84	976	10:00	LULOFF Gil	COATS Bob	HABU	2.3
31/07/84	973	11:00	MADISON Jack	ORCUTT Bill	HABU	2.3
01/08/84	976	19:45	MADISON Jack	ORCUTT Bill	N-HABU	2.2
03/08/84	976	13:00	LULOFF Gil	COATS Bob	HABU	0.6
06/08/84	973	13:00	LULOFF Gil	COATS Bob	HABU	2.3
07/08/84	971	10:15	MADISON Jack	ORCUTT Bill	HABU	2.3
09/08/84	971	09:15	LULOFF Gil	COATS Bob	HABU	1.5
10/08/84	976	10:30	LULOFF Gil	COATS Bob	HABU	2.2
13/08/84	976	19:15	GLASSER Jerry	TABOR Ron	N-HABU	2.4
15/08/84	973	11:00	LULOFF Gil	COATS Bob	HABU	2.4
17/08/84	973	08:00	GLASSER Jerry	TABOR Ron	HABU	2.3
22/08/84	976	19:10	LULOFF Gil	COATS Bob	N-HABU	2.2
24/08/84	976	09:45	GLASSER Jerry	TABOR Ron	HABU	2.4
27/08/84	976		LULOFF Gil	COATS Bob	HABU	
28/08/84	973	10:00	LULOFF Gil	COATS Bob	HABU	2.2
29/08/84	973	09:45	GLASSER Jerry	TABOR Ron	HABU	2.2
30/08/84	976	09:10	GLASSER Jerry	TABOR Ron	HABU	2.3
04/09/84	976	19:00	GLASSER Jerry	TABOR Ron	N-HABU	2.3
05/09/84	973	13:00	YEILDING Edward	LEE Steve	FCF	2.5
07/09/84	976	10:05	GLASSER Jerry	TABOR Ron	HABU	2.4
08/09/84	973	10:00	YEILDING Edward	LEE Steve	HABU	2.2
10/09/84	973	18:55	GLASSER Jerry	TABOR Ron	N-HABU	2.4
12/09/84	973	13:00	YEILDING Edward	LEE Steve	HABU	2.2
14/09/84	973	10:00	YEILDING Edward	LEE Steve	HABU	3.6
17/09/84	976	11:30	GLASSER Jerry	TABOR Ron	HABU	2.6
19/09/84	976	18:35	GLASSER Jerry	TABOR Ron	N-HABU	2.6
21/09/84	973	10:00	YEILDING Edward	LEE Steve	HABU	1.4
23/09/84	973	11:26	YEILDING Edward	LEE Steve	RTB FERRY	1.4
24/09/84	976	13:30	SMITH Bernie	WHALEN Denny	HABU	2.3
26/09/84	976	10:00	YEILDING Edward	LEE Steve	HABU	3.8
27/09/84	973	15:15	SMITH Bernie	WHALEN Denny	HABU	2.2
01/10/84	976	14:00	YEILDING Edward	LEE Steve	HABU	2.2
03/10/84	973	10:00	SMITH Bernie	WHALEN Denny	HABU	2.3
05/10/84	973	10:30	YEILDING Edward	LEE Steve	HABU	3.7
09/10/84	976	18:15	YEILDING Edward	LEE Steve	N-HABU	2.2
11/10/84	973	09:15	SMITH Bernie	WHALEN Denny	HABU	2.3
15/10/84	973	21:00	JIGGENS Jim	McCUE Joe	N-HABU	2.4
17/10/84	976	10:10	SMITH Bernie	WHALEN Denny	HABU	3.7
19/10/84	976	10:00	JIGGENS Jim	McCUE Joe	HABU	3.8
23/10/84	973	12:00	SMITH Bernie	WHALEN Denny	HABU	2.2
24/10/84	973	18:31	JIGGENS Jim	McCUE Joe	N-HABU	2.3
26/10/84	973		SMITH Bernie	WHALEN Denny	HABU	
30/10/84	976	12:42	SMITH Bernie	WHALEN Denny	HABU	2.3
31/10/84	976	11:30	JIGGENS Jim	McCUE Joe	HABU	3.8
01/11/84	976	09:30	CUNNINGHAM Nevin	MORGAN John	HABU	2.3
05/11/84	976	18:30	BOUDREAUX Stormy	ROSS Ted	N-HABU	2.5
07/11/84	976	11:30	CUNNINGHAM Nevin	MORGAN John	HABU	2.4
08/11/84	973	10:00	BOUDREAUX Stormy	ROSS Ted	FCF	2.4
09/11/84	976	11:00	CUNNINGHAM Nevin	MORGAN John	HABU	2.3
13/11/84	976	17:45	BOUDREAUX Stormy	ROSS Ted	N-HABU	2.3
14/11/84	973	16:00	CUNNINGHAM Nevin	MORGAN John	N-HABU	0.4
14/11/84	973	18:25	CUNNINGHAM Nevin	MORGAN John	N-HABU	2.4
16/11/84	976		BOUDREAUX Stormy	ROSS Ted	HABU	
17/11/84	976	11:00	BOUDREAUX Stormy	ROSS Ted	HABU	3.7
19/11/84	973	18:15	CUNNINGHAM Nevin	MORGAN John	N-HABU	2.3
21/11/84	976	09:15	BOUDREAUX Stormy	ROSS Ted	HABU	2.3
23/11/84	973	09:45	BOUDREAUX Stormy	ROSS Ted	HABU	2.3
27/11/84	973	15:00	BEHLER Bob	TABOR Ron	HABU	2.3
29/11/84	976	10:30	BOUDREAUX Stormy	ROSS Ted	HABU	4.1
03/12/84	973	11:15	BEHLER Bob	TABOR Ron	HABU	0.6
04/12/84	973	19:30	BEHLER Bob	TABOR Ron	N-HABU	2.3
06/11/84	976	10:15	BOUDREAUX Stormy	ROSS Ted	HABU	3.9
07/12/84	973	10:00	BEHLER Bob	TABOR Ron	HABU	2.3
11/12/84	964	06:00	BURK Bill	HENICHEK Tom	FERRY IN-H	6.6
13/12/84	976	08:00	BOUDREAUX Stormy	ROSS Ted	H-FERRY OUT	
15/12/84	973	09:15	BEHLER Bob	TABOR Ron	HABU	2.3
17/12/84	973	09:10	BEHLER Bob	TABOR Ron	HABU	5.6
19/12/84	964	17:45	BURK Bill	HENICHEK Tom	N-HABU	2.2
21/12/84	973	07:00	BURK Bill	HENICHEK Tom	HABU	6.2
26/12/84	964	18:15	BEHLER Bob	TABOR Ron	N-HABU	2.3
27/12/84	973	11:00	BURK Bill	HENICHEK Tom	HABU	2.5
28/12/84	964	09:05	BEHLER Bob	TABOR Ron	HABU	2.4
30/12/84	973	10:00	BURK Bill	HENICHEK Tom	HABU	3.6
02/01/85	964	10:00	BEHLER Bob	TABOR Ron	HABU	2.4
03/01/85	973	09:15	BURK Bill	HENICHEK Tom	HABU	1.9
07/01/85	964	10:30	MATTHEWS Joe	OSTERHELD Curt	HABU	3.8
09/01/85	973	23:30	BURK Bill	HENICHEK Tom	N-HABU	2.2
13/01/85	964	10:45	MATTHEWS Joe	OSTERHELD Curt	HABU	2.3

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Length
14/01/85	964	11:00	BURK Bill	HENICHEK Tom	HABU	3.7
17/01/85	964	07:10	MATTHEWS Joe	OSTERHELD Curt	HABU	4
21/01/85	964	09:30	BURK Bill	HENICHEK Tom	HABU	3.8
22/01/85	973	18:58	BURK Bill	HENICHEK Tom	HABU	0.5
23/01/85	973	18:30	BURK Bill	HENICHEK Tom	HABU	0.5
24/01/85	964	18:30	MATTHEWS Joe	OSTERHELD Curt	N-HABU	2.2
26/01/85	964	08:00	MATTHEWS Joe	OSTERHELD Curt	HABU	2.3
28/01/85	964	21:00	MATTHEWS Joe	OSTERHELD Curt	N-HABU	2.3
29/01/85	973	14:00	SHUL Brian	WATSON Walter	FCF	2.8
31/01/85	964	14:00	SHUL Brian	WATSON Walter	HABU	2.4
01/02/85	973	11:00	MATTHEWS Joe	OSTERHELD Curt	HABU	2.3
05/02/85	964	13:51	SHUL Brian	WATSON Walter	HABU	2.3
06/02/85	973	19:50	MATTHEWS Joe	OSTERHELD Curt	N-HABU	2.3
08/02/85	964	09:30	SHUL Brian	WATSON Walter	HABU	2.6
12/02/85	973	12:00	MATTHEWS Joe	OSTERHELD Curt	N-HABU	2.3
14/02/85	964	11:30	SHUL Brian	WATSON Walter	HABU	4.2
19/02/85	964	21:04	DYER Les	TABOR Ron	N-HABU	2.3
22/02/85	973	11:00	SHUL Brian	WATSON Walter	HABU	2.5
25/02/85	964	10:15	DYER Les	TABOR Ron	HABU	2.3
27/02/85	964	12:00	SHUL Brian	WATSON Walter	HABU	2.4
01/03/85	964	10:00	DYER Les	TABOR Ron	HABU	2.2
04/03/85	964	19:00	SHUL Brian	WATSON Walter	N-HABU	2.2
07/03/85	964	09:30	DYER Les	TABOR Ron	HABU	2.2
11/03/85	973	13:00	YEILDING Edward	LEE Steve	HABU	2.1
13/03/85	964	08:45	DYER Les	TABOR Ron	HABU	2.2
15/03/85	973	09:10	YEILDING Edward	LEE Steve	HABU	2.3
19/03/85	973	19:30	DYER Les	TABOR Ron	HABU	2.2
22/03/85	964	10:00	YEILDING Edward	LEE Steve	HABU	2.3
26/03/85	973	12:00	DYER Les	TABOR Ron	HABU	2.3
28/03/85	964		YEILDING Edward	LEE Steve	HABU	
28/03/85	973	14:00	YEILDING Edward	LEE Steve	HABU	2.3
01/04/85	973	11:00	SMITH Bernie	WHALEN Denny	HABU	2.3
03/04/85	964	11:00	YEILDING Edward	LEE Steve	HABU	2.3
05/04/85	973	11:30	SMITH Bernie	WHALEN Denny	HABU	3.9
09/04/85	973	09:10	YEILDING Edward	LEE Steve	HABU	2.2
10/04/85	964	19:30	SMITH Bernie	WHALEN Denny	N-HABU	1.9
12/04/85	964	11:38	YEILDING Edward	LEE Steve	HABU	2.3
15/04/85	964	11:00	SMITH Bernie	WHALEN Denny	N-HABU	2.4
16/04/85	973	12:00	YEILDING Edward	LEE Steve	HABU	2.6
18/04/85	964	15:00	SMITH Bernie	WHALEN Denny	HABU	2.3
22/04/85	964	10:45	SMITH Bernie	WHALEN Denny	HABU	2.3
23/04/85	964	09:50	DEAL Duane	VELTRI Tom	FCF	2.4
24/04/85	973	10:15	SMITH Bernie	WHALEN Denny	HABU	0.4
26/04/85	973	09:10	DEAL Duane	VELTRI Tom	HABU	2.4
29/04/85	964	12:01	DEAL Duane	VELTRI Tom	HABU	4
01/05/85	973	18:55	SMITH Bernie	WHALEN Denny	N-HABU	2.3
03/05/85	964	11:00	SMITH Bernie	WHALEN Denny	N-HABU	2.3
06/05/85	964	12:00	DEAL Duane	VELTRI Tom	HABU	2.4
07/05/85	973	10:15	SMITH Bernie	WHALEN Denny	HABU	2.3
09/05/85	964	10:00	DEAL Duane	VELTRI Tom	HABU	3.7
13/05/85	964	23:00	JIGGENS Jim	McCUE Joe	N-HABU	1.4
15/05/85	973	11:34	JIGGENS Jim	McCUE Joe	HABU	2.2
16/05/85	964	09:45	DEAL Duane	VELTRI Tom	HABU	2.2
21/05/85	973	19:30	DEAL Duane	VELTRI Tom	N-HABU	2.3
27/05/85	973	08:00	JIGGENS Jim	McCUE Joe	FCF	2.1
29/05/85	973	13:40	JIGGENS Jim	McCUE Joe	HABU	2.4
31/05/85	973	09:30	JIGGENS Jim	McCUE Joe	HABU	2.3
03/06/85	973	15:00	JIGGENS Jim	McCUE Joe	HABU	2.2
04/06/85	964	10:22	NOLL Duane	MORGAN Charlie	FCF	2.5
05/06/85	973	20:15	JIGGENS Jim	McCUE Joe	N-HABU	2.3
07/06/85	973	10:00	NOLL Duane	MORGAN Charlie	HABU	2.3
10/06/85	964	09:45	NOLL Duane	MORGAN Charlie	HABU	2.2
11/06/85	958	04:01	MADISON Jack	ORCUTT Bill	FERRY IN-H	6.6
12/06/85	964	19:20	JIGGENS Jim	McCUE Joe	N-HABU	2.3
13/06/85	958	11:00	TILDEN Tom	VIDA Joe	FCF DAFICS	3.6
14/06/85	973	10:00	MADISON Jack	ORCUTT Bill	HABU	4.5
17/06/85	958	13:10	TILDEN Tom	VIDA Joe	FCF DAFICS	3.7
18/06/85	964	20:18	JIGGENS Jim	McCUE Joe	N-HABU	2.5
19/06/85	958	11:53	TILDEN Tom	VIDA Joe	FCF DAFICS	2.6
21/06/85	973	11:20	NOLL Duane	MORGAN Charlie	HABU	2.2
24/06/85	958	10:15	NOLL Duane	MORGAN Charlie	HABU	2.3
25/06/85	973		JIGGENS Jim	McCUE Joe	H-FERRY OUT	
26/06/85	973	08:00	JIGGENS Jim	McCUE Joe	H-FERRY OUT	
28/06/85	964	12:00	MADISON Jack	ORCUTT Bill	HABU	2.4
01/07/85	964	19:30	NOLL Duane	MORGAN Charlie	N-HABU	2.2
03/07/85	958	09:30	MADISON Jack	ORCUTT Bill	HABU	2.2
09/07/85	958	12:00	NOLL Duane	MORGAN Charlie	HABU	2.3
11/07/85	958	09:15	MADISON Jack	ORCUTT Bill	HABU	2.3
16/07/85	964	09:45	BOUDREAUX Stormy	ROSS Ted	HABU	2.3
17/07/85	958	13:00	MADISON Jack	ORCUTT Bill	HABU	2.3

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Length
18/07/85	958	10:35	BOUDREAUX Stormy	ROSS Ted	HABU	2.4
21/07/85	958	10:00	BOUDREAUX Stormy	ROSS Ted	HABU	4.5
22/07/85	964	20:00	MADISON Jack	ORCUTT Bill	N-HABU	2.3
25/07/85	964	13:45	BOUDREAUX Stormy	ROSS Ted	HABU	2.3
31/07/85	968	04:30	SMITH Bernie	WHALEN Denny	FERRY IN-H	6
01/08/85	964	08:00	MADISON Jack	ORCUTT Bill	H-FERRY OUT	
02/08/85	968	09:20	BOUDREAUX Stormy	ROSS Ted	HABU	2.3
03/08/85	958	19:30	SMITH Bernie	WHALEN Denny	N-HABU	2.3
07/08/85	968	11:15	BOUDREAUX Stormy	ROSS Ted	HABU	2.3
09/08/85	968	10:15	SMITH Bernie	WHALEN Denny	HABU	2.2
14/08/85	958		BOUDREAUX Stormy	ROSS Ted	HABU	
19/08/85	968	11:03	SMITH Bernie	WHALEN Denny	HABU	3.9
23/08/85	958	11:30	BOUDREAUX Stormy	ROSS Ted	HABU	2.3
25/08/85	968	10:00	SMITH Bernie	WHALEN Denny	HABU	4.5
26/08/85	968	09:30	DYCKMAN Rod	BERGAM Tom	FCF	2.4
27/08/85	968	11:00	DYCKMAN Rod	BERGAM Tom	HABU	2.3
28/08/85	968	19:15	SMITH Bernie	WHALEN Denny	N-HABU	2.3
03/09/85	968	20:04	SMITH Bernie	WHALEN Denny	N-HABU	2.2
04/09/85	968	12:00	DYCKMAN Rod	BERGAM Tom	HABU	2.3
07/09/85	958	10:00	SMITH Bernie	WHALEN Denny	HABU	2.3
10/09/85	968	10:00	DYCKMAN Rod	BERGAM Tom	HABU	2.4
11/09/85	968	09:15	SMITH Bernie	WHALEN Denny	HABU	2.3
12/09/85	968		DYCKMAN Rod	BERGAM Tom	HABU	
13/09/85	968	10:00	DYCKMAN Rod	BERGAM Tom	HABU	0.5
14/09/85	968	10:00	DYCKMAN Rod	BERGAM Tom	HABU	1.5
17/09/85	958	11:00	MATTHEWS Joe	OSTERHELD Curt	HABU	2.2
18/09/85	968	18:35	MATTHEWS Joe	OSTERHELD Curt	N-HABU	2.3
21/09/85	958	09:34	DYCKMAN Rod	BERGAM Tom	HABU	2.1
23/09/85	968	18:45	DYCKMAN Rod	BERGAM Tom	N-HABU	2.3
26/09/85	958	08:15	MATTHEWS Joe	OSTERHELD Curt	HABU	2.3
27/09/85	968	10:30	DYCKMAN Rod	BERGAM Tom	HABU	2.3
01/10/85	958	11:09	DYCKMAN Rod	BERGAM Tom	HABU	2.2
02/10/85	968	11:00	MATTHEWS Joe	OSTERHELD Curt	HABU	2.5
07/10/85	958	18:33	MATTHEWS Joe	OSTERHELD Curt	N-HABU	2.3
09/10/85	968	12:10	MATTHEWS Joe	OSTERHELD Curt	HABU	2.3
11/10/85	958	09:45	GLASSER Jerry	TABOR Ron	HABU	2.4
15/10/85	968	18:15	MATTHEWS Joe	OSTERHELD Curt	HABU	3.0
17/10/85	958	12:02	MATTHEWS Joe	OSTERHELD Curt	HABU	2.3
18/10/85	958	10:45	GLASSER Jerry	TABOR Ron	HABU	3.7
21/10/85	968	10:30	MATTHEWS Joe	OSTERHELD Curt	FCF	2.1
22/10/85	958	13:05	GLASSER Jerry	TABOR Ron	HABU	2.3
23/10/85	968	10:15	MATTHEWS Joe	OSTERHELD Curt	FCF	2.3
24/10/85	958	09:12	GLASSER Jerry	TABOR Ron	HABU	2.4
28/10/85	968	10:30	DEAL Duane	VELTRI Tom	HABU	2.4
30/10/85	968	18:15	CUNNINGHAM Nevin	TABOR Ron	N-HABU	2.3
01/11/85	968	10:00	DEAL Duane	VELTRI Tom	HABU	2.3
05/11/85	958	09:30	CUNNINGHAM Nevin	TABOR Ron	HABU	2.3
06/11/85	968	09:32	DEAL Duane	VELTRI Tom	HABU	5.8
07/11/85	958	10:15	CUNNINGHAM Nevin	TABOR Ron	HABU	2.5
12/11/85	958	19:00	CUNNINGHAM Nevin	TABOR Ron	N-HABU	2.3
14/11/85	958	10:30	DEAL Duane	VELTRI Tom	HABU	3.8
19/11/85	968	11:00	SHUL Brian	WATSON Walter	HABU	1
21/11/85	958	10:30	DEAL Duane	VELTRI Tom	HABU	2.3
23/11/85	968	12:15	SHUL Brian	WATSON Walter	HABU	2.3
26/11/85	958	13:30	DEAL Duane	VELTRI Tom	HABU	2.2
27/11/85	958	11:30	SHUL Brian	WATSON Walter	HABU	2.4
29/11/85	958	09:10	DEAL Duane	VELTRI Tom	HABU	2.3
02/12/85	958	17:00	SHUL Brian	WATSON Walter	N-HABU	2.4
04/12/85	968	09:30	DEAL Duane	VELTRI Tom	HABU	2.3
07/12/85	968	11:30	SHUL Brian	WATSON Walter	HABU	2.2
09/12/85	958	09:32	SHUL Brian	WATSON Walter	HABU	5.9
11/12/85	968	18:15	SMITH Bernie	WHALEN Denny	N-HABU	2.3
13/12/85	968	09:03	SHUL Brian	WATSON Walter	HABU	2.3
17/12/85	958		SMITH Bernie	WHALEN Denny	N-HABU	
17/12/85	958	21:35	SMITH Bernie	WHALEN Denny	N-HABU	2.3
19/12/85	968	12:00	SHUL Brian	WATSON Walter	HABU	2.3
20/12/85	958	09:45	SMITH Bernie	WHALEN Denny	N-HABU	3.7
23/12/85	958	09:35	SHUL Brian	WATSON Walter	HABU	0.8
23/12/85	958	13:20	SHUL Brian	WATSON Walter	HABU	2.3
27/12/85	958	13:10	SMITH Bernie	WHALEN Denny	HABU	2.3
30/12/85	958	12:30	SMITH Bernie	WHALEN Denny	HABU	2.3

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Length
02/01/86	968	18:55	BOUDREAUX Stormy	ROSS Ted	N-HABU	2.3
07/01/86	958	12:00	SMITH Bernie	WALEN Denny	HABU	2.3
09/01/86	968	09:00	BOUDREAUX Stormy	ROSS Ted	HABU	2.4
10/01/86	968	11:00	SMITH Bernie	WALEN Denny	HABU	3.8
13/01/86	958	11:15	BOUDREAUX Stormy	ROSS Ted	HABU	2.3
15/01/86	958	09:45	SMITH Bernie	WALEN Denny	HABU	2.3
16/01/86	968	19:11	BOUDREAUX Stormy	ROSS Ted	HABU	2.3
21/01/86	968	17:35	BOUDREAUX Stormy	ROSS Ted	N-HABU	2.4
22/01/86	968	10:58	SMITH Milk	SOIFFR Douglas	ACFAM	2.5
23/01/86	958	10:00	BOUDREAUX Stormy	ROSS Ted	HABU	4
25/01/86	968	10:20	SMITH Milk	SOIFFR Douglas	HABU	3.2
27/01/86	958	19:00	BOUDREAUX Stormy	ROSS Ted	N-HABU	2.4
29/01/86	958	13:30	SMITH Milk	SOIFFR Douglas	HABU	2.4
03/02/86	958	17:55	BOUDREAUX Stormy	ROSS Ted	N-HABU	2.3
05/02/86	958		SMITH Milk	SOIFFR Douglas	HABU	
06/02/86	968	09:15	SMITH Milk	SOIFFR Douglas	HABU	2.3
07/02/86	958	10:45	SMITH Milk	SOIFFR Douglas	HABU	2.3
11/02/86	958	10:00	MADISON Jack	ORCUTT Bill	HABU	2.4
12/02/86	958	10:50	SMITH Milk	SOIFFR Douglas	HABU	3.9
14/02/86	968	10:30	MADISON Jack	ORCUTT Bill	HABU	2.3
17/02/86	958	09:10	SMITH Milk	SOIFFR Douglas	HABU	2.3
20/02/86	968	13:00	MADISON Jack	ORCUTT Bill	HABU	2.3
21/02/86	958	10:30	SMITH Milk	SOIFFR Douglas	HABU	3.9
24/02/86	958	10:10	MADISON Jack	ORCUTT Bill	HABU	2.5
26/02/86	968	11:00	SMITH Milk	SOIFFR Douglas	HABU	4
27/02/86	968	13:00	MADISON Jack	ORCUTT Bill	HABU	2.3
03/03/86	968	10:16	NOLL Duane	VELTRI Tom	HABU	2.3
04/03/86	958	10:00	MADISON Jack	ORCUTT Bill	HABU	3.9
06/03/86	968	18:30	NOLL Duane	VELTRI Tom	N-HABU	2.4
10/03/86	958	19:00	NOLL Duane	VELTRI Tom	N-HABU	2.3
12/03/86	968	11:30	MADISON Jack	ORCUTT Bill	HABU	2.4
17/03/86	958	11:00	MADISON Jack	ORCUTT Bill	HABU	3.9
18/03/86	968	10:30	NOLL Duane	VELTRI Tom	HABU	2.3
21/03/86	958	10:30	MADISON Jack	ORCUTT Bill	HABU	1.8
22/03/86	958	09:30	MADISON Jack	ORCUTT Bill	HABU	2.2
24/03/86	968	19:15	YEILDING Ed	LEE Steve	N-HABU	2.3
26/03/86	968	10:00	NOLL Duane	VELTRI Tom	HABU	2.3
27/03/86	968	09:35	YEILDING Ed	LEE Steve	HABU	2.3
28/03/86	958	09:15	NOLL Duane	VELTRI Tom	HABU	2.3
01/04/86	968	11:30	YEILDING Ed	LEE Steve	HABU	2.3
02/04/86	968		NOLL Duane	VELTRI Tom	HABU	
04/04/86	967	06:15	DYCKMAN Rod	BERGAM Tom	FERRY IN-H	6.6
05/04/86	958		NOLL Duane	VELTRI Tom	H-FERRY OUT	
06/04/86	958	10:00	NOLL Duane	VELTRI Tom	H-FERRY OUT	
08/04/86	968	10:00	YEILDING Ed	LEE Steve	HABU	3.7
11/04/86	968	10:00	DYCKMAN Rod	BERGAM Tom	HABU	4.7
15/04/86	967	09:45	YEILDING Ed	LEE Steve	HABU	2.2
16/04/86	967	19:35	DYCKMAN Rod	BERGAM Tom	N-HABU	2.3
18/04/86	968	11:45	YEILDING Ed	LEE Steve	HABU	2.3
21/04/86	967	19:30	DYCKMAN Rod	BERGAM Tom	N-HABU	2.3
23/04/86	968	12:00	YEILDING Ed	LEE Steve	HABU	2.2
25/04/86	968	11:15	DYCKMAN Rod	BERGAM Tom	HABU	2.3
29/04/86	967	13:05	YEILDING Ed	LEE Steve	HABU	2.3
01/05/86	968	09:30	DYCKMAN Rod	BERGAM Tom	HABU	2.4
07/05/86	968	10:00	MATTHEWS Joe	OSTERHELD Curt	HABU	3.7
08/05/86	967	15:00	DYCKMAN Rod	BERGAM Tom	HABU	2.2
09/05/86	968	11:00	MATTHEWS Joe	OSTERHELD Curt	HABU	2.3
12/05/86	968	19:15	MATTHEWS Joe	OSTERHELD Curt	N-HABU	2.3
14/05/86	968	09:45	MATTHEWS Joe	OSTERHELD Curt	HABU	2.3
16/05/86	968	11:30	DYCKMAN Rod	TABOR Ron	HABU	3.6
19/05/86	967		MATTHEWS Joe	OSTERHELD Curt	HABU	
20/05/86	968	09:15	MATTHEWS Joe	OSTERHELD Curt	HABU	2.4
21/05/86	967	10:15	DYCKMAN Rod	TABOR Ron	HABU	2.3
22/05/86	967	09:15	MATTHEWS Joe	OSTERHELD Curt	HABU	2.3
27/05/86	968	19:44	MATTHEWS Joe	OSTERHELD Curt	N-HABU	0.4
27/05/86	968	22:21	MATTHEWS Joe	OSTERHELD Curt	N-HABU	2.3
28/05/86	967	13:00	HOUSE Dan	BOZEK Blair	CRFAM	2.4
30/05/86	967	11:00	HOUSE Dan	BOZEK Blair	HABU	4
02/06/86	967	09:58	MATTHEWS Joe	OSTERHELD Curt	HABU	2.3
03/06/86	968	11:28	HOUSE Dan	BOZEK Blair	HABU	2.4
05/06/86	967	19:25	MATTHEWS Joe	OSTERHELD Curt	N-HABU	2.3
09/06/86	967	11:00	HOUSE Dan	BOZEK Blair	HABU	3.9
12/06/86	967	09:30	MATTHEWS Joe	OSTERHELD Curt	HABU	2.3
13/06/86	968	11:00	HOUSE Dan	BOZEK Blair	HABU	1.9
16/06/86	967	10:00	HOUSE Dan	BOZEK Blair	HABU	2.2
17/06/86	968	09:15	JIGGENS Jim	ROSS Ted	HABU	2.4
18/06/86	968	12:00	HOUSE Dan	BOZEK Blair	HABU	2.1
20/06/86	968	09:45	JIGGENS Jim	ROSS Ted	HABU	2.4
21/06/86	967	11:57	HOUSE Dan	BOZEK Blair	HABU	2.2
21/06/86	967	19:30	JIGGENS Jim	ROSS Ted	N-HABU	2.2
27/06/86	968	12:00	HOUSE Dan	BOZEK Blair	FCF	2.6
02/07/86	968	09:35	HOUSE Dan	BOZEK Blair	HABU	1.9
03/07/86	967	10:57	JIGGENS Jim	ROSS Ted	HABU	0.7
03/07/86	967	15:42	JIGGENS Jim	ROSS Ted	HABU	2.2
07/07/86	967	20:15	SHUL Brian	WATSON Walter	N-HABU	2.3
09/07/86	968	10:17	JIGGENS Jim	ROSS Ted	HABU	2.3
11/07/86	968	09:43	SHUL Brian	WATSON Walter	HABU	2.3
15/07/86	967	09:43	JIGGENS Jim	ROSS Ted	HABU	2.4
17/07/86	968	11:59	SHUL Brian	WATSON Walter	HABU	2.3
18/07/86	967	09:59	JIGGENS Jim	ROSS Ted	HABU	2.3
21/07/86	968	19:27	JIGGENS Jim	ROSS Ted	N-HABU	2.4
24/07/86	967	10:07	SHUL Brain	WATSON Walter	HABU	2.3
28/07/86	968	10:42	SMITH Mike	SOIFER Douglas	HABU	2.3
30/07/86	967	11:25	SHUL Brain	WATSON Walter	HABU	2.4
01/08/86	968	09:26	SMITH Mike	SOIFER Douglas	HABU	2.3
04/08/86	968	11:23	SHUL Brain	WATSON Walter	HABU	2.3
05/08/86	968	19:20	SMITH Mike	SOIFER Douglas	N-HABU	2.3
08/08/86	968	09:40	SHUL Brain	WATSON Walter	HABU	2.2
11/08/86	968	19:15	SMITH Mike	SOIFER Douglas	N-HABU	2.4
13/08/86	967	11:09	SHUL Brain	WATSON Walter	HABU	2.3
14/08/86	968	10:00	SMITH Mike	SOIFER Douglas	HABU	2.3
18/08/86	967	10:53	NOLL Duane	VELTRI Tom	HABU	2.4
20/08/86	968	19:25	NOLL Duane	VELTRI Tom	N-HABU	2.2
22/08/86	967	10:25	SMITH Mike	SOIFER Douglas	HABU	2.3
28/08/86	967	09:26	NOLL Duane	VELTRI Tom	HABU	2.3
29/08/86	967	10:40	SMITH Mike	SOIFER Douglas	HABU	2.3
01/09/86	968	11:00	SMITH Mike	SOIFER Douglas	HABU	2.3
04/09/86	967	19:30	NOLL Duane	VELTRI Tom	N-HABU	2.3
06/09/86	967	09:30	NOLL Duane	VELTRI Tom	HABU	2.2
08/09/86	968	11:25	MADISON Jack	LEE Steve	HABU	2.3
10/09/86	968	10:00	NOLL Duane	VELTRI Tom	HABU	2.2
11/09/86	967	19:30	MADISON Jack	LEE Steve	N-HABU	0.5
11/09/86	968	21:45	MADISON Jack	LEE Steve	N-HABU	2.2
13/09/86	967	09:45	NOLL Duane	VELTRI Tom	HABU	2.2
15/09/86	968	20:04	NOLL Duane	VELTRI Tom	N-HABU	2.3
17/09/86	967	07:00	NOLL Duane	VELTRI Tom	HABU	2.4
18/09/86	967	05:55	MADISON Jack	LEE Steve	HABU	2.7
24/09/86	967	10:00	NOLL Duane	VELTRI Tom	HABU	3.2
27/09/86	967	10:00	MADISON Jack	LEE Steve	HABU	4.5
01/10/86	968	10:18	DANIELSON Tom	GUDMUNDSON Stan	ACFAM	2.3
02/10/86	967	12:30	MADISON Jack	LEE Steve	HABU	3.5
06/10/86	968	10:30	DANIELSON Tom	GUDMUNDSON Stan	HABU	2.3
08/10/86	967	18:10	DANIELSON Tom	GUDMUNDSON Stan	N-HABU	2.3
10/10/86	968	09:45	MADISON Jack	LEE Steve	HABU	2.3
14/10/86	967	18:20	MADISON Jack	LEE Steve	N-HABU	2.5
16/10/86	968	09:58	DANIELSON Tom	GUDMUNDSON Stan	HABU	2.2
20/10/86	968	18:40	DANIELSON Tom	GUDMUNDSON Stan	N-HABU	2.3
22/10/86	967	11:30	SMITH Bernie	ORCUTT Bill	HABU	3.2
24/10/86	968	10:50	DANIELSON Tom	GUDMUNDSON Stan	HABU	2.3
27/10/86	968	09:15	SMITH Bernie	ORCUTT Bill	HABU	2.2
28/10/86	967	11:10	SMITH Bernie	ORCUTT Bill	HABU	2.2
30/10/86	968	09:10	SMITH Bernie	ORCUTT Bill	HABU	3.7
03/11/86	968	10:58	SMITH Bernie	ORCUTT Bill	HABU	2.2
07/11/86	967	12:10	DANIELSON Tom	GUDMUNDSON Stan	HABU	4.5
12/11/86	968	17:50	MATTHEWS Joe	MORGAN John	N-HABU	2.3
14/11/86	968	10:15	NOLL Duane	VELTRI Tom	HABU	3.9
17/11/86	967	12:10	MATTHEWS Joe	MORUGAN John	HABU	2.2
18/11/86	968	19:40	NOLL Duane	VELTRI Tom	N-HABU	2.3
20/11/86	968	09:50	MATTHEWS Joe	MORGAN John	HABU	2.2
21/11/86	967	10:30	NOLL Duane	VELTRI Tom	HABU	3.9
24/11/86	968	10:05	MATTHEWS Joe	MORGAN John	HABU	3.5
25/11/86	967	12:10	NOLL Duane	VELTRI Tom	HABU	2.2
01/12/86	968	09:10	DYCKMAN Rod	BERGAM Tom	HABU	2.3
02/12/86	967	10:01	PAPPAS Terry	MANZI John	CRFAM	2.5
03/12/86	968	18:00	DYCKMAN Rod	BERGAM Tom	N-HABU	2.3
05/12/86	968	09:36	PAPPAS Terry	MANZI John	HABU	2.4
08/12/86	968	09:50	DYCKMAN Rod	BERGAM Tom	HABU	2.4
10/12/86	967	09:10	DYCKMAN Rod	BERGAM Tom	HABU	5.7
11/12/86	968	17:45	PAPPAS Terry	MANZI John	N-HABU	2.4
15/12/86	967	10:35	PAPPAS Terry	MANZI John	HABU	2.4
16/12/86	968	09:20	DYCKMAN Rod	BERGAM Tom	HABU	2.4
18/12/86	967		PAPPAS Terry	MANZI John	HABU	
18/12/86	967	12:50	PAPPAS Terry	MANZI John	HABU	2.4
22/12/86	967	17:40	YEILDING Ed	OSTERHELD Curt	N-HABU	2.2
23/12/86	968	13:00	PAPPAS Terry	MANZI John	HABU	2.3
29/12/86	967	10:45	YEILDING Ed	OSTERHELD Curt	HABU	3.9
01/01/87	967	09:35	PAPPAS Terry	MANZI John	HABU	2.8
05/01/87	968	09:59	YEILDING Ed	OSTERHELD Curt	HABU	2.2

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Length
06/01/87	967	18:00	PAPPAS Terry	MANZI John	N-HABU	2.3
08/01/87	968	10:21	YEILDING Ed	OSTERHELD Curt	HABU	3.3
12/01/87	967		HOUSE Dan	BOZEK Blair	N-HABU	
13/01/87	967		HOUSE Dan	BOZEK Blair	N-HABU	
14/01/87	967	10:45	HOUSE Dan	BOZEK Blair	HABU	2.4
15/01/87	968	11:00	YEILDING Ed	OSTERHELD Curt	HABU	1.9
16/01/87	967	11:00	HOUSE Dan	BOZEK Blair	HABU	2.3
20/01/87	968	18:40	YEILDING Ed	OSTERHELO Curt	N-HABU	2.3
21/01/87	967	14:50	HOUSE Dan	BOZEK Blair	HABU	2.4
23/01/87	967	10:20	YEILDING Ed	OSTERHELD Curt	HABU	2.3
26/01/87	968	11:35	HOUSE Dan	BOZEK Blair	HABU	2.3
27/01/87	967	18:05	YEILDING Ed	OSTHRHELD Curt	N-HABU	2.3
29/01/87	967	13:07	HOUSE Dan	BOZEK Blair	HABU	2.4
02/02/87	968		HOUSE Dan	BOZEK Blair	HABU	
02/02/87	968	09:51	HOUSE Dan	BOZEK Blair	HABU	2.3
03/02/87	967		SHUL Brain	WATSON Walter	HABU	
04/02/87	967		SHUL Brain	WATSON Walter	HABU	
05/02/87	967	10:20	SHUL Brian	WATSON Walter	HABU	3.8
06/02/87	968	09:54	HOUSE Dan	BOZEK Blair	HABU	2.3
07/02/87	968	10:05	SHUL Brian	WATSON Walter	HABU	2.2
09/02/87	967	19:07	HOUSE Dan	BOZEK Blair	N-HABU	2.4
11/02/87	967	12:11	SHUL Brian	WATSON Walter	HABU	2.3
13/02/87	968	09:50	HOUSE Dan	BOZEK Blair	HABU	2.4
17/02/87	967	09:10	SHUL Brian	WATSON Walter	HABU	2.3
18/02/87	968	10:35	HOUSE Dan	BOZEK Blair	HABU	2.3
19/02/87	967	11:55	SHUL Brian	WATSON Walter	HABU	3.2
24/02/87	968	19:25	SMITH Mike	SOIFER Douglas	N-HABU	2.4
26/02/87	968	09:35	SHUL Brian	WATSON Walter	HABU	2.3
02/03/87	968	09:05	SMITH Mike	SOIFER Douglas	HABU	2.3
04/03/87	968	10:20	SHUL Brian	WATSON Walter	HABU	2.3
05/03/87	967	10:28	SMITH Mike	SOIFER Douglas	FCF	1.1
07/03/87	967	09:25	SHUL Brian	WATSON Walter	HABU	2.6
10/03/87	967	19:15	SMITH Mike	SOIFER Douglas	N-HABU	2.4
12/03/87	967	11:40	SHUL Brian	WATSON Walter	HABU	2.8
17/03/87	967	18:50	NOLL Duane	VELTRI Tom	N-HABU	2.2
20/03/87	968	10:45	SMITH Mike	SOIFER Douglas	HABU	1.8
20/03/87	968	15:56	SMITH Mike	SOIFER Douglas	HABU	0.5
21/03/87	967	10:00	NOLL Duane	VELRI Tom	HABU	2.2
23/03/87	967	18:50	SMITH Mike	SOIFER Douglas	N-HABU	2.3
25/03/87	968		SMITH Mike	SOIFER Douglas	HABU	
26/03/87	967	10:17	SMITH Mike	SOIFER Douglas	HABU	3.3
27/03/87	968	09:50	NOLL Dunne	VELTRI Tom	HABU	2.3
01/04/87	967	09:45	SMITH Mike	SOIPER Douglas	HABU	2.3
02/04/87	968	10:35	NOLL Duane	VELTRI Tom	HABU	2.3
04/04/87	967	12:36	NOLL Duane	VELTRI Tom	HABU	4.2
06/04/87	967	12:00	McKENDREE Mac	SHELHORSE Randy	CRFAM	2.5
07/04/87	968	10:00	McKENDREE Mac	SHELHORSE Randy	HABU	2.3
09/04/87	967	18:50	NOLL Dunne	VELTRI Tom	N-HABU	2.3
14/04/87	967		McKENDREE Mac	SHELHORSE Randy	HABU	
16/04/87	967	11:00	McKENDREE Mac	SHELHORSE Randy	HABU	4
17/04/87	968	12:00	NOLL Duane	VELTRI Tom	HABU	2.2
20/04/87	967	19:00	McKENDREE Mac	SHELHORSE Randy	N-HABU	2.3
23/04/87	968	09:50	NOLL Duane	VELTRI Tom	HABU	2.3
27/04/87	967	19:00	McKENDREE Mac	SHELHORSE Randy	N-HABU	2.4
29/04/87	968	10:00	DANIELSON Tom	GUDMUNDSON Stan	HABU	2.3
02/05/87	967	11:09	McKENDREE Mac	SHELHORSE Randy	HABU	2.1
05/05/87	967		DANIELSON Tom	GUDMUNDSON Stan	HABU	
05/05/87	967	12:11	DANIELSON Tom	GUDMUNDSON Stan	HABU	2.2
07/05/87	968	10:45	McKENDREE Mac	SHELHORSE Randy	HABU	3.7
11/05/87	968	09:30	DANIELSON Tom	GUDMUNDSON Stan	HABU	3.3
13/05/87	975	11:30	YEILDING Ed	OSTERHELD Curt	FERRY IN-H	6.9
14/05/87	968	08:00	McKENDREE Mac	SHELHORSE Randy	H-FERRY OUT	
18/05/87	967	10:45	DANIELSON Tom	GUDMUNDSON Stan	HABU	2
20/05/87	967	12:00	YEILDING Ed	OSTERHELD Curt	HABU	3.5
22/05/87	967	09:45	DANIELSON Tom	GUDMUNDSON Stan	HABU	2.1
26/05/87	975	19:43	YEILDING Ed	OSTERHELD Curt	N-HABU	2.1
28/05/87	967	09:15	DANIELSON Tom	GUDMUNDSON Stan	HABU	2.2
01/06/87	975	11:00	YEILDING Ed	OSTERHELD Curt	HABU	2.1
02/06/87	967	19:36	DANIELSON Tom	GUDMUNDSON Stan	N-HABU	2.1
04/06/87	975	11:05	YEILDING Ed	OSTERHELD Curt	HABU	3.6
08/06/87	975	19:20	SMITH Mike	SOIFER Doug	N-HABU	2.1
12/06/87	967	10:10	YIELDING Ed	OSTERHELD Curt	HABU	2.2
16/06/87	975	12:20	SMITH Mike	SOIFER Doug	HABU	1.6
17/06/87	967		YEILDING Ed	OSTERHELD Curt	HABU	
17/06/87	967	11:54	YEILDING Ed	OSTERHELD Curt	HABU	4.2
22/06/87	967		SMITH Mike	SOIFER Doug	N-HABU	
22/06/87	967	21:18	SMITH Mike	SOIFER Doug	N-HABU	2.2
24/06/87	975	11:55	YEILDING Ed	OSTERHELD Curt	HABU	2.2
25/06/87	967	11:15	SMITH Mike	SOIFER Doug	HABU	2.2
29/06/87	967	09:57	SMITH Mike	SOIFER Doug	HABU	2.2
30/06/87	975		BROWN Larry	CARTER Keith	CRFAM	
30/06/87	975	16:24	BROWN Larry	CARTER Keith	CHFAM	2.4
01/07/87	967	13:00	BROWN Larry	CARTER Keith	CRFAM	2.1

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Length
06/07/87	975	13:10	SMITH Mike	SOIFER Doug	N-HABU	2.1
08/07/87	967	10:36	BROWN Larry	CARTER Keith	HABU	2.2
10/07/87	975	09:32	SMITH Mike	SOIFER Doug	HABU	2.2
13/07/87	975	09:20	BROWN Larry	CARTER Keith	HABU	2.2
16/07/87	967	10:35	SMITH Mike	SOIFER Doug	HABU	2.5
17/07/87	967	10:34	BROWN Larry	CARTER Keith	HABU	2.2
20/07/87	975	09:30	PAPPAS Terry	MANZI John	HABU	2.4
22/07/87	975	11:00	YEILDING Ed	OSTERHELD Curt	HABU	4.3
22/07/87	967	10:16	SMITH Mike	SOIFER Doug	HABU	11.2
28/07/87	975	13:35	BROWN Larry	CARTER Keith	HABU	2.1
30/07/87	967	18:52	PAPPAS Terry	MANZI John	N-HABU	2.3
03/08/87	967	10:05	BROWN Larry	CARTER Keith	HABU	2.2
04/08/87	975	18:50	PAPPAS Terry	MANZI John	N-HABU	1.5
06/08/87	975	10:45	BROWN Larry	CARTER Keith	HABU	2.1
09/08/87	975	11:30	PAPPAS Terry	MANZI John	HABU	11.1
09/08/87	967	12:19	BROWN Larry	CARTER Keith	HABU	4.4
14/08/87	967	13:41	SMITH Bernie	BERGAM Tom	HABU	2.2
18/08/87	967	11:52	PAPPAS Terry	MANZI John	HBAU	0.4
18/08/87	967	16:01	PAPPAS Terry	MANZI John	HABU	2.2
24/08/87	975	12:20	SMITH Bernie	BERGAM Tom	HABU	2.1
27/08/87	967	09:22	PAPPAS Terry	MANZI John	HABU	2.1
01/09/87	967	13:00	SMITH Barnic	BERGAM Tom	HABU	2.1
03/09/87	967	10:06	HOUSE Dan	BOZEK Blair	HABU	2.1
08/09/87	967	18:25	SMITH Barnic	BERGAM Tom	N-HABU	0.4
08/09/87	967	21:09	SMITH Barnic	BERGAM Tom	N-HABU	2.1
09/09/87	975	15:19	HOUSE Dan	BOZEK Blair	HABU	2.2
11/09/87	967	13:00	SMITH Barnic	BERGAM Tom	HABU-100	2.3
15/09/87	975	10:00	HOUSE Dan	BOZEK Blair	HABU	2.2
17/09/87	967	12:11	SMITH Barnic	BERGAM Tom	HABU	2.5
21/09/87	967	10:45	HOUSE Dan	BOZEK Blair	HABU	3.3
22/09/87	975	17:50	HOUSE Dan	BOZEK Blair	N-HABU	2.1
22/09/87	967	12:00	GRZEBINIAK Steve	GREENWOOD Jim	CRWFAM	2.5
24/09/87	975	10:34	GRZEBINIAK Steve	GREENWOOD Jim	HABU	3.8
26/09/87	967	09:45	HOUSE Dan	BOZEK Blair	HABU	2.1
29/09/87	975	10:15	GRZEBINIAK Steve	GREENWOOD Jim	HABU	2.1
02/10/87	967	10:00	HOUSE Dan	BOZEK Blair	HABU	3.7
05/10/87	967	17:20	GRZEBINIAK Steve	GREENWOOD Jim	N-HABU	2.1
13/10/87	975	11:47	McKENDREE Mac	SHELHORSE Randy	HABU	1.8
15/10/87	967	11:19	GRZEBINIAK Steve	GREENWOOD Jim	HABU	3.2
17/10/87	975	08:45	McKENDREE Mac	SHELHORSE Randy	HABU	2.1
19/10/87	975		GRZEBINIAK Steve	GREENWOOD Jim	HABU	
20/10/87	967	09:35	GRZEBINIAK Steve	GREENWOOD Jim	HABU	2.1
23/10/87	975	11:00	McKENDREE Mac	SHELHORSE Randy	HABU	2.1
26/10/87	975	12:05	HOUSE Dan	BOZEK Blair	HABU	2.5
26/10/87	967	11:00	McKENDREE Mac	SHELHORSE Randy	HABU	10.8
28/10/87	975	10:30	McKENDREE Mac	SHELHORSE Randy	HABU	3.6
02/11/87	975	10:05	NOLL Duane	VELTRI Tom	HABU	3.7
06/11/87	967	10:15	McKENDREE Mac	SHELHORSE Randy	HABU	3.9
11/11/87	967	11:20	NOLL Duane	VELTRI Tom	HABU	3.2
14/11/87	975	09:05	McKENDREE Mac	SHELHORSE Randy	HABU	2.1
16/11/87	967	09:30	NOLL Duane	VELTRI Tom	FCF	2
19/11/87	974		MADISON Jack	BERGAM Tom	FERRY IN/HABU	6.4
20/11/87	967	07:00	McKENDREE Mac	SHELHORSE Randy	HABU/FERRY OUT	
23/11/87	975	09:25	NOLL Duane	VELTRI-Tom	HABU	2.1
24/11/87	975	11:00	MADISON Jack	BERGAM Tom	HABU	3.7
02/12/87	974	11:20	NOLL Duane	VELTRI Tom	HABU	2.1
04/12/87	975	10:05	MADISON Jack	BERGAM Tom	HABU	4
08/12/87	974	17:55	NOLL Duane	VELTRI Tom	N-HABU	1
09/12/87	975	12:00	NOLL Duane	VELTRI Tom	HABU	2.2
10/12/87	975	11:39	MADISON Jack	BERGAM Tom	HABU	3.4
15/12/87	974	13:26	DANIELSON Tom	GUDMUNDSON Stan	HABU	2.2
16/12/87	975	12:30	MADISON Jack	BERGAM Tom	HABU	2.2
21/12/87	974		DANIELSON Tom	GUDMUNDSON Stan	HABU	
21/12/87	974		DANIELSON Tom	GUDMUNDSON Stan	HABU	
22/12/87	975	11:30	DANIELSON Tom	GUDMUNDSON Stan	HABU	2.1
29/12/87	974	09:55	MADISON Jack	BERGAM Tom	HABU	2.1
04/01/88	975	17:40	DANIELSON Tom	GUDMUNDSON Stan	N-HABU	2.3
06/01/88	974	10:55	BROWN Larry	CARTER Keith	HABU	2.1
12/01/88	974	12:15	DANIELSON Tom	GUDMUNDSON Stan	HABU	2.1
16/01/88	974	13:20	BROWN Larry	CARTER Keith	HABU	2.1
21/01/88	974	09:35	DANIELSON Tom	GUDMUNDSON Stan	HABU	5.5
22/01/88	975	11:10	SMITH Bernie	CARTER Keith	FCF	2.1
25/01/88	975	11:25	SMITH Milk	SOIFER Doug	HABU	2
28/01/88	975		SMITH Bernie	CARTER Keith	HABU	
28/01/88	975		SMITH Bernie	CARTER Keith	HABU	
29/01/88	974		SMITH Bernie	CARTER Keith	HABU	
30/01/88	974	15:00	SMITH Bernie	CARTER Keith	HABU	0.7
31/01/88	974	15:00	SMITH Bernie	CARTER Keith	HABU	3.2
01/02/88	974	11:15	SMITH Milk	SOIFER Doug	HABU	2.1
04/02/88	974	13:25	SMITH Bernie	CARTER Keith	HABU	2.2
09/02/88	975	10:40	SMITH Milk	SOIFER Doug	HABU	2.1
12/02/88	974	08:05	SMITH Bernie	CARTER Keith	HABU	5.2
16/02/88	975	09:40	SMITH Milk	SOIFER Doug	HABU	2.1

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Length
17/02/88	974	10:45	McCLEARY Tom	VARDAMAN Blue	CRFAM	2.2
18/02/88	974	15:00	McCLEARY Tom	VARDAMAN Blue	HABU	3.3
22/02/88	975	18:05	SMITH Milk	SOIFER Doug	N-HABU	2.2
29/02/88	974	08:35	McCLEARY Tom	VARDAMAN Blue	HABU	5.3
03/03/88	975	10:17	DYCKMAN Rod	WATSON Walt	HABU	2
04/03/88	975	10:45	McCLEARY Tom	VARDAMAN Blue	HABU	3.8
09/03/88	975	09:55	DYCKMAN Rod	WATSON Walt	HABU	2.1
14/03/88	975	08:19	McCLEARY Tom	VARDAMAN Blue	HABU	3.7
16/03/88	975	10:20	DYCKMAN Rod	WATSON Walt	HABU	2.2
22/03/88	974	18:27	PAPPAS Terry	MANZI John	N-HABU	2.1
29/03/88	974	12:01	HOUSE Dan	BOZEK Blair	HABU	2.1
05/04/88	975	13:36	PAPPAS Terry	MANZI John	HABU	2.2
07/04/88	974	08:53	HOUSE Dan	BOZEK Blair	HABU	3.4
14/04/88	975	10:15	PAPPAS Terry	MANZI John	HABU	2.2
15/04/88	974		HOUSE Dan	BOZEK Blair	HABU	
15/04/88	975	09:51	HOUSE Dan	BOZEK Blair	HABU	5.2
20/04/88	974	18:35	GRZEBINIAK Steve	GREENWOOD Jim	N-HABU	2.1
21/04/88	975	11:45	HOUSE Dan	BOZEK Blair	FCF	2.2
28/04/88	974	14:00	GRZEBINIAK Steve	GREENWOOD Jim	HABU	2.4
30/04/88	974	09:17	HOUSE Dan	BOZEK Blair	HABU	10.9
30/04/88	975		GRZEBINIAK Steve	GREENWOOD Jim	HABU-G/A	
04/05/88	974	19:05	McKENDREE Mac	SHELHORSE Randy	N-HABU	2.2
10/05/88	975	09:05	GRZEBINIAK Steve	GREENWOOD Jim	HABU	3.5
14/05/88	974	09:50	McKENDREE Mac	SHELHORSE Randy	FCF	2
18/05/88	975	10:30	GRZEBINIAK Steve	GREENWOOD Jim	FCF	2.3
20/05/88	974	15:00	McKENDREE Mac	SHELHORSE Randy	HABU	1.5
21/05/88	974	10:00	GRZEBINIAK Steve	GREENWOOD Jim	HABU	2.2
23/05/88	974	14:10	McKENDREE Mae	SHELHORSE Randy	HABU	2.2
26/05/88	974	10:20	GRZEBINIAK Steve	GREENWOOD Jim	HABU	4.8
27/05/88	974	12:25	McKENDREE Mae	SHELHORSE Randy	HABU	1.9
02/06/88	974	13:10	PAPPAS Terry	MANZI John	FCF	2.1
06/06/88	975	11:30	McKENDREE Mae	SHELHORSE Randy	HABU	2.3
09/06/88	974	11:18	PAPPAS Terry	MANZI John	FCF	2.2
14/06/88	975	09:50	McKENDREE Mae	SHELHORSE Randy	HABU	2.1
16/06/88	974	11:00	PAPPAS Terry	MANZI John	FCF	2.1
17/06/88	975	12:10	McCLEARY Tom	BERGAM Tom	HABU	1.9
21/06/88	974	12:30	PAPPAS Terry	MANZI John	HABU	2.1
22/06/88	975	09:09	McCLEARY Tom	BERGAM Tom	HABU	3.5
28/06/88	974	10:00	McCLEARY Tom	BERGAM Tom	FCF	2.1
30/06/88	975	07:06	PAPPAS Terry	MANZI John	HABU/FERRY OUT	
03/07/88	979	05:00	BROWN Larry	CARTER Keith	FERRY IN/HABU	6.3
07/07/88	979	09:06	BROWN Larry	CARTER Keith	HABU	3.2
08/07/88	974	12:00	CRITTENDEN Greg	FINAN Mike	FCF	2.1
12/07/88	974	10:00	CRITTENDEN Greg	FINAN Mike	FCF	4.3
15/07/88	979	10:00	CRITTENDEN Greg	FINAN Mike	FCF	2.3
16/07/88	974		BROWN Larry	CARTER Keith	HABU	
18/07/88	974	12:10	BROWN Larry	CARTER Keith	HABU	2.3
20/07/88	974	10:13	CRITTENDEN Greg	FINAN Mike	FCF	1.5
21/07/88	979	10:55	BROWN Larry	CARTER Keith	HABU	4.2
28/07/88	974	09:35	CRITTENDEN Greg	FINAN Mike	HABU	2.2
31/07/88	979	13:00	DYCKMAN Rod	MANZI John	HABU	2.1
02/08/88	974	09:44	CRITTENDEN Greg	FINAN Mike	HABU	2.2
04/08/88	979	11:00	CRITTENDEN Greg	FINAN Mike	HABU	1.9
06/08/88	979	09:30	DYCKMAN Rod	MANZI John	HABU	4.2
12/08/88	979	09:12	DYCKMAN Rod	MANZI John	HABU/FERRY OUT	
17/08/88	974	14:50	CRITTENDEN Greg	FINAN Mike	HABU	1.1
23/08/88	974	11:45	SMITH Mike	SOIFER Doug	HABU	2.2
25/08/88	974	10:40	NOLL Duane	VELTRI Tom	HABU	2
29/08/88	974	09:30	SMITH Mike	SOIFER Doug	HABU	2.3
31/08/88	974	11:35	NOLL Duane	VELTRI Tom	HABU	2.1
02/09/88	974	09:20	SMITH Mike	SOIFER Doug	HABU	3.3
07/09/88	974	09:01	NOLL Duane	VELTRI Tom	FCF	1.9
08/09/88	974	10:01	SMITH Mike	SOIFER Doug	FCF	2.2
12/09/88	974	09:05	NOLL Duane	VELTRI Tom	HABU	4.7
14/09/88	974	10:36	WATKINS Don	FOWLKES Bob	CREAM	2.2
16/09/88	974	09:07	WATKINS Don	FOWLKES Bob	HABU	3.3
19/09/88	974	09:30	HOUSE Dan	BOZER Blair	FCF	4
20/09/88	974	09:30	WATKINS Don	VELTRI Tom	FCF	2.2
27/09/88	974	11:45	WATKINS Don	FOWLKES Bob	FCF	1.9
29/09/88	974	10:31	HOUSE Dan	BOZER Blair	FCF	2.2
01/10/88	974	10:45	WATKINS Don	FOWLKES Bob	FCF	2.1
12/10/88	974	09:05	HOUSE Dan	BOZER Blair	FCF	2.1
20/10/88	974	14:00	HOUSE Dan	BOZER Blair	FCF	2.1
27/10/88	974	18:15	HOUSE Dan	BOZER Blair	N-FCF	2.2
02/11/88	974	10:02	HOUSE Dan	BOZER Blair	FCF	2.2
08/11/88	974	09:32	McCLEARY Tom	BERGAM Tom	FCF	2.2

Date	No.	T.O. Time	Pilot Name	RSO Name	Mission Type	Length
15/11/88	974	17:50	McCLEARY Tom	BERGAM Tom	N-FCF	2.3
21/11/88	974	11:00	McCLEARY Tom	BERGAM Tom	FCF	2.2
29/11/88	974	17:45	McCLEARY Tom	BERGAM Tom	N-FCF	2.3
07/12/88	974	10:06	BROWN Larry	CARTER Keith	FCF	0.6
08/12/88	974		BROWN Larry	CARTER Keith	FCF	
15/12/88	974	10:00	BROWN Larry	CARTER Keith	FCF	2.1
19/12/88	974	11:00	BROWN Larry	CARTER Keith	FCF	4
21/12/88	974	11:01	BROWN Larry	CARTER Keith	FCF	2.7
04/01/89	974	11:00	NOLL Duane	MANZI John	FCF	2.1
19/01/89	974	08:01	NOLL Duane	MANZI John	FCF	2.7
24/01/89	974		NOLL Duane	MANZI John	FCF	
25/01/89	974	15:02	NOLL Duane	MANZI John	FCF	2.2
30/01/89	974	18:30	NOLL Duane	MANZI John	N-FCF	2.5
07/02/89	974	11:00	GRZEBINIAK Steve	GREENWOOD Jim	FCF	2.1
17/02/89	974	12:49	GRZEBINIAK Steve	GREENWOOD Jim	FCF	2.6
22/02/89	974	12:49	GRZEBINIAK Steve	GREENWOOD Jim	N-FC	2.2
28/02/89	974	11:30	GRZEBINIAK Steve	GREENWOOD Jim	FCF	2.2
10/03/89	974	11:29	CRITTENDEN Greg	BERGAM Tom	FCF	1.2
14/03/89	974	18:50	CRITTENDEN Greg	FINAN Mike	N-FCF	2
16/03/89	974	09:30	CRITTENDEN Greg	FINAN Mike	FCF	2
27/03/89	974	10:30	CRITTENDEN Greg	FINAN Mike	FCF	3.9
31/03/89	974	10:00	HOUSE Dan	BOZEK Blair	HABU	3.3
01/04/89	974	12:21	HOUSE Dan	BERGAM Tom	FCF	1.6
10/04/89	974	08:46	HOUSE Dan	BOZEK Blair	HABU	3.2
12/04/89	974	14:25	HOUSE Dan	BERGAM Tom	FCF	2.2
14/04/89	974	09:46	HOUSE Dan	BOZEK Blair	HABU	3.5
21/04/89	974	09:30	HOUSE Dan	BOZEK Blair	HABU	
09/06/89	962	07:04	McKENDREE Mac	SHELHORSE Randy	FERRY IN/HABU	6.2
15/06/89	962	08:45	McKENDREE Mac	SHELHORSE Randy	HABU	3
20/06/89	962	19:51	McKENDREE Mac	SHELHORSE Randy	N-HABU	5.4
22/06/89	962	10:00	McKENDREE Mac	SHELHORSE Randy	FCF	2.1
23/06/89	962	14:00	McKENDREE Mac	SHELHORSE Randy	HABU	3.2
27/06/89	962	08:00	McKENDREE Mac	SHELHORSE Randy	HABU	4.8
29/06/89	962	09:10	McKENDREE Mac	SHELHORSE Randy	HABU	3.4
06/07/89	962	08:45	McKENDREE Mac	SHELHORSE Randy	HABU	3.6
11/07/89	962	09:15	McKENDREE Mac	SHELHORSE Randy	HABU	3.7
13/07/89	962	09:30	McKENDREE Mac	SHELHORSE Randy	HABU	3.6
17/07/89	962	07:00	McKENDREE Mac	SHELHORSE Randy	HABU	5.4
24/07/89	962	10:11	McKENDREE Mac	SHELHORSE Randy	HABU	3.5
28/07/89	962	08:07	McCLEARY Thomas	GUDMUNDSON Stan	FCF	4.2
03/08/89	962	12:00	McCLEARY Thomas	GUDMUNDSON Stan	FCF	2.2
04/08/89	962		McCLEARY Thomas	GUDMUNDSON Stan	HABU	
09/08/89	962	09:15	McCLEARY Thomas	GUDMUNDSON Stan	HABU	3.8
11/08/89	962	10:00	McCLEARY Thomas	GUDMUNDSON Stan	HABU	3.8
15/08/89	962	09:05	McCLEARY Thomas	GUDMUNDSON Stan	HABU	3.7
21/08/89	962	09:48	CRITTENDEN Greg	FINAN Milk	HABU	3.7
23/08/89	962	15:00	CRITTENDEN Greg	FINAN Milk	N-HABU	5.3
28/08/89	962	11:02	CRITTENDEN Greg	GUDMUNDSON Stan	FCF	3.9
01/09/89	962	08:59	CRITTENDEN Greg	FINAN Milk	HABU	3.6
06/09/89	962		CRITTENDEN Greg	FINAN Milk	HABU	
18/09/89	962		WATKINS Don	FOWLKES Bob	HABU	
19/09/89	962	09:05	WATKINS Don	FOWLKES Bob	HABU	3.3
23/09/89	962	11:00	SMITH Milk	FOWLKES Bob	RTH FERRY	2.3
25/09/89	962	09:10	WATKINS Don	FOWLKES Bob	HABU	3.4
05/10/89	962	12:30	SMITH Milk	FOWLKES Bob	FCF	1.6
06/10/89	962	12:00	WATKINS Don	FOWLKES Bob	FCF	1.5
21/10/89	962	10:08	HOUSE Dan	BOZEK Blain	FCF	2.3
26/10/89	962	18:09	HOUSE Dan	BOZEK Blain	Nite-FCF	2.3
31/10/89	962	11:10	HOUSE Dan	BOZEK Blain	FCF	2.3
02/11/89	962	09:00	HOUSE Dan	BOZEK Blain	FCF	0.6
03/11/89	962	10:30	HOUSE Dan	BOZEK Blain	FCF	1.9
06/11/89	962	09:30	HOUSE Dan	BOZEK Blain	FCF	2.2
07/11/89	962	10:00	HOUSE Dan	SHELHORSE Randy	FCF	1.1
14/11/89	962	11:50	GRZEBINIAK Steve	GREENWOOD Jim	FCF	2.3
17/11/89	962	09:15	GRZEBINIAK Steve	GREENWOOD Jim	FCF	1.9
21/11/89	962	11:10	GRZEBINIAK Steve	GREENWOOD Jim	FCF	2.2
28/11/89	962	11:10	GRZEBINIAK Steve	WALTON Charles	HIGH SPEED TAXI	
05/12/89	962		GRZEBINIAK Steve	GREENWOOD Jim	FCF	A
06/12/89	962	10:00	GRZEBINIAK Steve	GREENWOOD Jim	FCF/CREW PROFICHENCYO	
14/12/89	962	11:00	GRZEBINIAK Steve	ADRIAN David	HIGH SPEED TAXI	
18/12/89	962	08:10	GRZEBINIAK Steve	GREENWOOD Jim	FCF	2.5
18/01/90	962	10:28	GRZEBINIAK Steve	GREENWOOD Jim	FCF	3.7
21/01/90	962	05:00	GRZEBINIAK Steve	GREENWOOD Jim	FERRY OUT	

Abbreviations in this appendix	
CCTM	Combat Crew Training Mission (Crew orientation flight)
FCF	Functional Check Flight
HABU	Operational SR-71 Mission
N-HABU	Night operational SR-71 Mission
Ferry to SC-5	Ferry aircraft back to beale aircraft base.

THE HABU'S DEAD, LONG LIVE THE HABU

APPENDIX 3
DET 4 DEPLOYMENTS

Serial number	Deployment date	Redeployment date
61-7972	9/9/74	13/9/74
61-7972	20/4/76	30/4/76
61-7962	6/9/76	18/9/76
61-7958	7/1/77	17/1/77
61-7958	16/5/77	31/5/77
61-7976	24/10/77	16/11/77
61-7964	24/4/78	12/5/78
61-7964	16/10/78	2/11/78
61-7972	12/3/79	28/3/79
61-7979	17/4/79	2/5/79
61-7976	18/10/79	13/11/79
61-7976	9/4/80	9/5/80
61-7972	13/9/80	2/11/80
61-7964	12/12/80	7/3/81
61-7972	6/3/81	5/5/81
61-7964	16/8/81	6/11/81 (Div. from Bodø)
61-7958	16/12/81	21/12/81
61-7980	5/1/82	27/4/82
61-7974	30/4/82	13/12/82
61-7972	18/12/82	6/7/83
61-7971	23/12/82	2/2/83
61-7980	7/3/83	6/9/83
61-7955	9/7/83	30/7/83 (False serial 962)
61-7974	2/8/83	??/7/84
61-7958	9/9/83	12/6/84
61-7979	14/6/84	Mid/7/85
61-7975	Mid/7/84	16/10/84
61-7962	19/10/84	Mid/10/85
61-7980	19/7/85	29/10/86
61-7960	29/10/85	29/1/87
61-7973	1/11/86	22/7/87 (For repairs)
61-7964	5/2/87	Mid/3/88
61-7980	27/7/87	3/10/88 (From Lakenheath)
61-7971	13/3/88	28/2/89
61-7964	5/10/88	18/1/90*
61-7967	2/3/89	19/1/90

* This aircraft completed an operational mission into the Barents Sea after several fly-bys at Mildenhall upon its departure despite the fact that the programme had been terminated the previous November.

APPENDIX 4
A-12, M-21, YF-12A AND SR-71 CHECK FLIGHTS

Check Ride No.	Category	Position/Rank	Name
001	Plt	ADP	Lou Schalk
000	VIP	ADP	Kelly Johnson
002	Plt	ADP	Bill Park
003	Plt	ADP	Jim Eastham
004	Plt	ADP	Bob Gilliland
005	Plt	CIA	William L. Skliar
006	Plt	CIA	Kenneth S. Collins
007	Plt	CIA	Walter L. Ray
008	Plt	CIA	Dennis B. Sullivan
009	Plt	CIA	Alonzo J. Walter
010	Eng	ADP	Larry Edgar
011	Eng	ADP	Hank Stockham
012	Eng	ADP	Torrey Larsen
013	Plt	ADP	Darrell Greenamyer
014	FCO	Hughes	Tony Byland
015	FCO	Hughes	Ray Scalise
016	Eng	ADP	R. L. Dick Miller
017	Plt	ADP	Art Peterson
018	FCO	Hughes	George Parsons
019	Plt	ADP	Bill Weaver
020	RSO	ADP	Jim Zwayer
021	FCO	Hughes	John Archer
022	Eng	ADP	Keith Beswick
023	RSO	ADP	George Andre
024	RSO	ADP	Steven A. Belgeau
025	RSO	ADP	Ray Torick
026	Eng	ADP	Larry Bohanan
027	Eng	ADP	Glen Fulkerson
028	Plt	CIA	Jack J. Layton
029	Plt	CIA	Mele Vojvodich
030	Plt	CIA	Jack C. Weeks
031	RSO	ADP	Kenneth E. Moeller
032	VIP	ADP	Rus Danielll
033	Plt	CIA	Francis J. Murray
034	Plt	CIA	Russell J. Scott
101	Plt	Col	Robert I. Stephens
102	FCO	Lt-Col	Daniel Andre
103	FCO	Maj	Noel T. Warner
104	FCO	Capt	James P. Cooney
105	Plt	Maj	Walter F. Daniel

Check Ride No.	Category	Position/Rank	Name
106	FCO	Capt	Sammel M. Ursini
107	RSO	Maj	Kenneth D. Hurley
108	Plt	Maj	Charles C. Bock
109	Plt	Col	Vern Henderson
110	Plt	Lt-Col	Jacques G. Beezley
111	Plt	Col	H. A. Templeton
112	Plt	Maj	Mervin L. Evenson
113	Plt	Maj	Allen L. Hichew
114	RSO	Capt	Tom W. Schmittou
115	Plt	Maj	Robert G. Sowers
116	RSO	Capt	Richard E. Sheffield
117	RSO	Capt	Cosimo B. Mallozzi
118	Plt	Lt-Col	Ray Haupt
119	RSO	Lt-Col	Cecil H. Braeden
120	RSO	Capt	James W. Fagg
121	RSO	Maj	William R. Payne
122	Plt	Col	Frenchy D. Bennett
123	VIP	Brig-Gen	H. B. Manson
124	Plt	Lt-Col	Joe Rogers
125	VIP	Lt-Col	Ralph Richardson
126	Plt	Col	Robert J. Holbury
127	Plt	Col	Hugh C. Slater
128	Plt	Maj	Harold E. Burgeson
129	Plt	Lt-Col	B. S. Barrett
130	Plt	Lt-Col	Roland L. Perkim
131	RSO	Lt-Col	Norman S. Drake
132	Plt	Maj	Ben Bowles
133	RSO	Lt-Col	Harold C. Peterson
134	Plt	Maj	William J. Campbell
135	RSO	Capt	Albert N. Pennington
136	Plt	Col	Douglas T. Nelson
137	RSO	Lt-Col	Russel L. Lewis
138	Plt	Maj	Patrick J. Halloran
139	RSO	Capt	Mortimer J. Jarvis
140	RSO	Capt	David P. Dempster
141	Plt	Maj	Buddy L. Brown
142	RSO	Capt	David J. Jensen
143	Plt	Capt	Charles W. Collins
144	RSO	Capt	Jean C. Seagroves
145	Plt	Maj	John H. Storrie
146	Plt	Maj	Jack Kennon
147	Plt	Capt	Franklin D. Shelton
148	RSO	Capt	Lawrence L. Boggess
149	Plt	Lt-Col	William L. Skliar
150	Plt	Maj	Jerome F. O'Malley
151	RSO	Capt	Edward D. Payne
152	Plt	Maj	Donald A. Walbrecht
153	RSO	Capt	Phillip G. Loignon
154	Plt	Capt	Earle M. Boone
155	RSO	Capt	Dewain C. Vick
156	Staf	Col	Russell K. Weller
157	Plt	Maj	James L. Watkins
158	Plt	Maj	Anthony P. Bevacqua
159	Staf	Col	William P. Hayes
160	RSO	Capt	Robert J. Rotcisoender
161	RSO	Maj	William C. Keller
162	RSO	Maj	Donald E. Mathers
163	Plt	Capt	Robert C. Spencer
164	Plt	Col	Harold E. Confer
165	RSO	Capt	Clyde L. Shoemaker
166	Plt	Maj	Brian K. McCallom
167	VIP	Lt-Col	James C. Schever
168	RSO	Maj	Jerald L. Crew
169	Plt	Maj	Larry S. Devall
170	RSO	Capt	Ruel K. Branham
171	RSO	Maj	Thomas A. Casey
172	Plt	Maj	Roy L. St Martin
173	RSO	Capt	Robert M. Locke
174	Plt	Maj	George M. Bull
175	RSO	Capt	John F. Carnochan
176	Staf	Col	John B. Boynton
177	Plt	Maj	Robert M. Powell
178	RSO	Maj	Charles J. McNeer
179	Plt	Maj	Charles E. Daubs
180	Eng	Maj	William A. Lusby
181	Eng	Civ	Robert W. Sudderth
182	RSO	Capt	William I. Kendrick
183	Staf	Col	Charles F. Minter Sr
184	Eng	Civ	Richard Abrams
185	Plt	Capt	Bobby L. Campbell
186	VIP	Gen	Bruce Holloway (CINC)
187	VIP	Lt Gen	Arthur C. Agan
188	VIP	Lt Gen	William K. Martin
189	Plt	Maj	Gabriel A. Kardong
190	VIP	Lt Gen	Jack J. Catton (15th AF/CC)
191	RSO	Capt	Gary Heidlebauch
192	RSO	Maj	Jon P. Kraus
193	Plt	Maj	Lothar J. Maier
194	Plt	Maj	William E. Lawson III
195	RSO	Maj	James A. Kogler
196	RSO	Maj	Gary L. Coleman
197	RSO	Maj	Gilbert Martinez
198	RSO	Lt-Col	Harold E. Chapman
199	Plt	Capt	David E. Fruehauf
200	VIP	Col	Benjamin N. Bellis
201	RSO	Capt	Allen R. Payne

Check Ride No.	Category	Position/Rank	Name
202	Plt	Maj	James W. Hudson
203	RSO	Capt	Norbet L. Budzinske
204	RSO	Maj	Donn A. Byrnes
205	RSO	Maj	Bruce Hartman
206	RSO	Maj	R. W. Weaver Jr
207	Plt	Lt-Col	Harlon A. Hain
208	RSO	Maj	Don Rhude
209	Plt	Maj	Richard C. Gerard
210	Plt	Maj	Thomas B. Estes
211	RSO	Maj	Charles G. McLean
212	RSO	Maj	Ken G. Moeller
213	Plt	Lt-Col	Kenneth S. Collins
214	Plt	Maj	James H. Shelton Jr
215	Plt	Capt	Reverdy J. Allender
216	VIP	Lt-Col	Fred Trost
217	Plt	Lt-Col	Dennis B. Sullivan
218	Plt	Lt-Col	Mel Vojvodich
219	Plt	Capt	Bruce E. Wilcox
220	Plt	Maj	E. L. Payne (EAFB)
221	VIP	Senator	Barry Goldwater
222	Staf	Lt-Col	Ronald J. Layton
223	Staf	Col	James E. Anderson
224	VIP	Brig-Gen	Alton Slay
225	VIP	Col	William R. Payne
226	Plt	Maj	Darrel W. Cobb
227	RSO	Capt	Myron L. Gantt
228	Plt	NASA	Fitzhugh L. Fulton Jr
229	Plt	Maj	Thomas S. Pugh
230	Plt	NASA	Donald L. Mallick
231	RSO	Maj	Ronnie C. Rice
232	Plt	Capt	Dennis K. Bush
233	Plt	Capt	Randolph B. Hertzog
234	Plt	Col	D. B. Sullivan
235	RSO	Maj	Ronald L. Selberg
236	Staf	Lt-Col	Roy W. Owen Jr
237	RSO	Maj	Billy A. Curtis
238	Plt	Maj	George H. Sewell Jr
239	RSO	Capt	Reginald T. Blackwell
240	VIP	Lt Gen	P. K. Carlton 15th AF/CC
241	RSO	Capt	George T. Morgan
242	Plt	Capt	Robert J. Cunningham
243	RSO	NASA	Victor W. Horton
244	VIP	Col	Ross Spinkle
245	Plt	Capt	Monty T. Judkin
246	VIP	Brig-Gen	Lukeman
247	Plt	Maj	Caroll D. Gunther
248	RSO	NASA	William R. Young
249	RSO	Capt	Thomas R. Allocca

Check Ride No.	Category	Position/Rank	Name
250	Staf	Brig-Gen	Edgar S. Harris Jr
251	VIP	Congressman	Robert Price
252	Plt	Capt	Carl A. Haller
253	VIP	Maj-Gen	Salvador E. Felices
254	cancelled		
255	Plt	Maj	A. H. Bledsoe
256	RSO	Maj	Cletius C. Rogers
257	Plt	Maj	James V. Sullivan
258	RSO	Capt	Noel F. Widdifield
259	RSO	Capt	John T. Fuller
260	Plt	Capt	Leland B. Ransom III
261	RSO	Maj	Mark H. Gersten
262	Plt	Capt	Harold B. Adams
263	RSO	Capt	William C. Machorek
264	Plt	Capt	Robert C. Helt
265	RSO	Capt	Larry A. Elliott
266	Plt	Capt	Eldon W. Joersz
267	Plt	Capt	James F. Wilson
268	VIP	Maj-Gen	George W. McLaughlin
269	RSO	Capt	Bruce S. Douglass
270	VIP	Sec of AF	John L. McLucas
271	VIP	Lt Gen	William F. Pitts (15th AF/CC)
272	VIP	Brig-Gen	Don D. Pittman (14th AD/CC)
273	Plt	Capt	Maury Rosenberg
274	RSO	Capt	Donald C. Bulloch
275	VIP	Lt-Col	Hal Rupard
276	VIP	Lt-Col	Jackie G. Reed
277	Plt	Lt-Col/AFLC	Tom Smith
278	Staf	Lt-Col	Raphael S. Samay
279	Plt	Capt	Joseph C. Kinego
280	RSO	Capt	Roger L. Jacks
281	VIP	Maj-Gen	Ray B. Sitton
282	VIP	Hon	Malcom R. Currie
283	VIP	Hon	Walter B. Laberge
284	Plt	Capt	Alan B. Cirino
285	RSO	Capt	Bruce L. Liebman
286	Plt	Capt	Justin J. Murphy
287	VIP	Gen	Albert L. Melton
288	RSO	Maj	John A. Billingsley
289	VIP	Lt Gen	James M. Keck (Vice CINC)
290	VIP	Maj-Gen	Billy J. Ellis
291	Plt	Capt	Richard H. Graham
292	RSO	Capt	Donald R. Emmons
293	VIP	Maj-Gen	Herbert J. Gavin
294	Plt	Capt	Thomas M. Alison
295	Plt	Maj./AFLC	Robert L. Riedenauer AFLC
296	RSO	Maj./AFLC	William J. Frazier AFIC
297	RSO	Maj	Joseph T. Vida

Check Ride No.	Category	Position/Rank	Name
298	VIP	Col	Merlyn H. Dethlefsen
299	VIP	Lt Gen	Bryan M. Shotts (15th AF/CC)
300	VIP	Lt Gen	Andrew B. Anderson Jr
301	VIP	Maj-Gen	John W. Burkhart
302	Staf	Col	Robert D. Beckel
303	VIP	Maj-Gen	Otis Moore
304	Staf	Col	Richard J. Bower
305	Plt	Capt	William G. Gilmore
306	Plt	Maj	Robert W. Crowder
307	RSO	Capt	John G. Morgan
308	VIP	Gen	Russ E. Dougherty (CINC)
309	Plt	Capt	Adelbert W. Carpenter
310	VIP	Lt Gen	John W. Roberts
311	RSO	Capt	John E. Murphy
312	VIP	Brig-Gen	Gerald E. Cooke
313	VIP	Mr	James W. Plummer
314	RSO	Capt	William C. Keller
315	VIP	Lt Gen	Robert E. Hails
316	Staf	Col	Lyman M. Kidder
317	VIP	Hon	James B. Connor
318	Plt	Maj	John J. Veth
319	Plt	Maj	William G. Groninger
320	RSO	Capt	Charles T. Sober Jr
321	Plt	Maj	Bredette Thomas
322	VIP	Brig-Gen	Bill V. Brown (14th AD/CC)
323	RSO	Capt	Jay Reid
324	VIP	Maj-Gen	Earl G. Peck
325	Staf	Col	John W. Fenimore
326	Plt	Capt	Thomas J. Keck
327	RSO	Capt	Timothy J. Shaw
328	Plt	NASA	John Manke
329	Plt	NASA	Bill Dana
330	Plt	NASA	Gary E. Krier
331	Plt	NASA	Einar K. Enevoldson
332	Plt	NASA	Thomas C. McMurtry
333	Plt	Maj	David M. Peters
334	RSO	Capt	Michael L. Stockton
335	VIP	Col	Ted H. Shadburn
336	RSO	Capt	Edgar J. Bethart Jr
337	Plt	Maj	Lee M. Shelton III
338	Staf	Col	Andrew G. Terry
339	Staf	Col	David G. Young
340	VIP	Lt Gen	Robert C. Mathis
341	RSO	Maj	Barry C. MacKean
342	Plt	Lt-Col/AFLC	Calvin F. Jewett AFIC
343	Plt	Capt	Richard A. Young
344	cancelled		
345	RSO	Capt	Russell L. Szczepanik
346	VIP	Reverend	Theodore M. Hesburgh
347	VIP	Lt Gen	James P. Mullins (15th AF/CC)
348	Plt	NASA	Stephen D. Ishmael
349	Plt	NASA	Michael R. Swann
350	VIP	Brig-Gen	John A. Brashear (14th AD/CC)
351	Plt	Capt	Calvin J. Augustin
352	RSO	Maj	Frank K. Kelly
353	VIP	Col	Joseph S. Stanton
354	VIP	Senator	Howard W. Cannon
355	Plt	Capt	Gilbert M. Bertelson
356	RSO	Capt	Frank W. Stampf
357	VIP	Civ	Frank A. Fishburne
358	Plt	Capt	Richard W. Judson
359	cancelled		
360	VIP	Lt Gen	Lloyd R. Leavitt Jr
361	Plt	Maj	Nevin N. Cunningham
362	RSO	Capt	Gene R. Quist
363	cancelled		
364	Plt	Capt	Dennis R. Berg
365	RSO	Maj/AFLC	Bill Flanagan
366	VIP	Civ	Jim Hartz
367	RSO	Capt	E. D. McKim
368	Plt	Maj	Gerald T. Glasser
369	cancelled		
370	RSO	Capt	David M. Hornbaker
371	VIP	Civ	Robert R. Ropelewske
372	Plt	Capt	Richard S. McCrary
373	RSO	Capt	David A. Lawrence
374	Plt	Maj	Bernard J. Smith
375	VIP	Maj-Gen	John T. Chain Jr
376	RSO	Maj	Dennis W. Whalen
377	VIP	Brig-Gen	Monroe W. Hatch (14th AD/CC)
378	Plt	Capt	Gary I. Luloff
379	VIP	Gen	Bennie L. Davis (CINC)
380	RSO	Capt	Robert L. Coats
381	VIP	Lt Gen	John J. Murphy
382	VIP	Congressman	Robert K. Dornan
383	Plt	Maj	Leslie R. Dyer
384	RSO	Capt	Daniel Greenwood
385	VIP	Lt Gen	George D. Miller (Vice CINC)
386	VIP	Maj-Gen	Louis C. Buckman (SAC/DO)
387	Staf	Col	Lonnie L. Liss
388	Plt	Capt	William Burk
389	Plt	Maj/AFLC	Thomas V. Tilden
390	VIP	Gen	Lew Allen (CS/Air Force)
391	RSO	Capt	Thomas J. Henichek

Check Ride No.	Category	Position/Rank	Name
392	VIP	Brig-Gen	Jesse S. Hocker (14th AD/CC)
393	Plt	Capt	James M. Jiggins
394	RSO	Capt	Joseph J. McCue
395	VIP	Sec of AF	Edward 'Pete' Aldridge
396	VIP	Lt Gen	Andrew P. Iosue
397	Plt	Maj	Robert F. Behler
398	RSO	Capt	Ronald D. Tabor
399	VIP	Congressman	'Bill' C. W. Young
400	Plt	Maj	Lionel P. Boudreax
401	RSO	Capt	Walter F. Newgreen
402	VIP	Lt Gen	Lawrence A. Skantze
403	Plt	Maj	Joseph E. Matthews
404	RSO	Capt	Edward W. Ross
405	VIP	Brig-Gen	Charles Yeager
406	RSO	Capt	Douglas C. Osterheld
407	Staf	Col	George V. Freese
408	Staf	Col	David H. Pinsky
409	Plt	Capt	Jack E. Madison
410	VIP	Lt Gen	James E. Light (15th AF/CC)
411	RSO	Maj	William D. Orcutt
412	Plt	Capt	Ed Yeilding
413	RSO	Capt	Stephen M. Lee
414	Plt	Maj	Brian Shul
415	RSO	Maj	Waiter I. Watson
416	Plt	Capt	Duane W. Deal
417	RSO	Capt	Thomas F. Veltri
418	Plt	Maj	Duane M. Noll
419	RSO	Capt	Charles A. Morgan
420	VIP	Congressman	Bob Stump
421	Plt	Maj	William R. Dyckman
422	RSO	Maj	Thomas E. Bergam
423	Staf	Brig-Gen	John Farrington (14th AD/CC)
424	Plt	Maj	Michael L. Smith
425	RSO	Capt	Douglas B. Soifer
426	Staf	Col	Robert B. McConnell
427	Staf	Maj-Gen	Alexander Davidson (AF/XO)
428	RSO	Maj	Phillip I. Soucy
429	VIP	Congressman	Beverly Byron
430	Plt	Maj	Dan E. House
431	RSO	Capt	Blair L. Bozek
432	VIP	Gen	Larry D. Welch (CINC)
433	Plt	Maj	Thomas J. Danielson
434	VIP	Congressman	Robert E. Badham
435	RSO	Maj	Stanley J. Gudmundson
436	Plt	Maj	Terry D. Pappas
437	RSO	Capt	John D. Manzi
438	Staf	Col	James Sarvada
439	VIP	Maj-Gen	Hansford T. Johnson SAC/DO
440	Plt	Maj	Warren C. Mckendree
441	RSO	Maj	Randy F. Shelhorse
442	VIP	Congressman	Larry J. Hopkins
443	Plt	Maj	Larry Brown
444	RSO	Maj	Keith E. Carter
445	Plt	Capt	Steven Grzebiniak
446	RSO	Capt	James F. Greenwood
447	Plt	Maj	Thomas R. McCleary
448	RSO	Capt	Hunter W. Vardaman
449	VIP	Lt Gen	Kenneth L. Peek (Vice CINC)
450	Staf	Brig-Gen	Howell M. Estes (14th AD/C)
451	Staf	Col	Donald R. Schreiber
452	Plt	Capt	Gregory N. Crittenden
453	RSO	Maj/AFLC	Tom Fuhrman AFIC
454	RSO	Maj	Michael J. Finan
455	Plt	Maj	Donald T. Watkins
456	RSO	Capt	Robert E. Fowlkes
457	Plt	Capt	Ben Snyder
458	RSO	Capt	Briggs Shade
459	Staf	Brig-Gen	Kenneth F. Keller (14th AD/CC)
460	VIP	Lt Gen	Ellie G. Shuler Jr (8AF/CC)
461	cancelled		
462	Plt	Maj/AFLC	Jim Halsell
463	Staf	Maj-Gen	John L. Borling
464	Plt	NASA	Roger Smith
465	FE	NASA	Marta Bohn-Meyer
466	FE	NASA	Robert E. Meyer

Note the jump in check ride numbers from 034 to 101. This due to the allocation of numbers 000 to 100 to the Oxca programme, some of which were not taken up prior to i termination. The Senior Crown programme was allocated th numbers 101 onward.

APPENDIX 5 BLACKBIRD DISPOSITION

A12

Tail No.	LAC No.	First Flight	Last Flight	No. of flights	Total Hours
60-6924	121	26 April 1962	?	322	418.2
	Remarks	Prototype, now on display at the Blackbird Air Park, Palmdale, CA.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**No. of flights**	**Total Hours**
60-6925	122	?	?	161	177.9
	Remarks	Displayed on board the Intrepid Sea, Air & Space Museum, New York City, NY.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**No. of flights**	**Total Hours**
60-6926	123	?	24 May 1963	79	135.3
	Remarks	Crashed 24 May 1963: pilot Ken Collins survived.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**No. of flights**	**Total Hours**
60-6927	124	?	?	614	1076.4
	Remarks	Displayed at California Science Center, Los Angeles, CA.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**No. of flights**	**Total Hours**
60-6928	125	?	5 Jan 1967	202	334.9
	Remarks	Crashed 5 Jan 1967: pilot Walter Ray killed.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**No. of flights**	**Total Hours**
60-6929	126	?	28 Dec 1967	105	169.2
	Remarks	Crashed 28 Dec 1967: pilot Mel Vojvodich survived.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**No. of flights**	**Total Hours**
60-6930	127	?	?	258	499.2
	Remarks	Displayed at the US Space and Rocket Center, Huntsville, AL.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**No. of flights**	**Total Hours**
60-6931	128	?	?	232	453
	Remarks	Displayed at CIA Headquarters, Langley, VA.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**No. of flights**	**Total Hours**
60-6932	129	?	5 Jun 1968	268	409.9
	Remarks	Crashed 5 June 1968: pilot Jack Weeks killed.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**No. of flights**	**Total Hours**
60-6933	130	27 Nov 1963	Aug 1965	217	406.3
	Remarks	Displayed at the San Diego Aerospace Museum, CA.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**No. of flights**	**Total Hours**
60-937	131	?	?	177	345.8
	Remarks	Displayed at the Southern Museum of Flight, Birmingham, AL.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**No. of flights**	**Total Hours**
60-6938	132	?	?	197	369.9
	Remarks	Displayed at the USS Alabama Battleship Memorial Park, Mobile, AL.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**No. of flights**	**Total Hours**
60-6939	133	?	?	10	8.3
	Remarks	Crashed 9 July 1964: pilot Bill Park survived.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**No. of flights**	**Total Hours**
60-6940	134	?	?	80	123.9
	Remarks	Converted to M-21 to carry D-21 drone. Displayed at the Museum of Flight, Seattle, WA.			

Tail No.	LAC No.	First Flight	Last Flight	No. of flights	Total Hours
60-6941	135	?	30 Jul 1966	95	152.7
	Remarks	Converted to M-21 to carry D-21 drone. Crashed 30 July 1966: pilot Bill Park survived, Launch Control Officer Ray Torick killed.			

YF-12A

Tail No.	LAC No.	First Flight	Last Flight	First Flt Crew	Total Hours
60-6934	1001	8 Aug 1963	14 Aug 1966	Jim Eastham	180.9
	Remarks	Converted into SR-71 trainer, referred to as SR-71C and given the serial number 61-7981, displayed at Hill AFB Utah.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
60-6935	1002	26 Nov 1963	7 Nov 1979	Lou Schalk	534.7
	Remarks	Displayed at the National Museum of the US Air Force, Wright Patterson AFB, OH.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
60-6936	1003	13 Mar 1964	24 Jul 1971	Bob Gilliland	439.8
	Remarks	Crashed 24 July 1971: pilot Jack Layton and FCO Bill Curtis both survived.			

SR-71

Tail No.	LAC No.	First Flight	Last Flight	First Flt Crew	Total Hours
61-7950	2001	23 Dec 1964	10 Jan 1967	Bob Gilliland	?
	Remarks	Written off on 10 Jan 1967: pilot Art Peterson survived.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7951	2002	5 Mar 1965	22 Dec 1978	Gilliland/Zwayer	796.7
	Remarks	Displayed at the Pima Air Museum, Tucson, AZ.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7952	2003	24 Mar 1965	25 Jan 1966	?	?
	Remarks	Crashed 25 Jan 1966: pilot Bill Weaver survived, RSO Jim Zwayer killed.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7953	2004	4 Jun 1965	18 Dec 1969	Weaver/Andre	?
	Remarks	Crashed 18 Dec 1969: pilot Joe Rogers and RSO Gary Heidelbaugh both survived.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7954	2005	20 Jul 1965	11 Apr 1969	Weaver/Andre	?
	Remarks	Written off 11 April 1969: pilot Bill Skliar and RSO Noel Warner both survived.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7955	2006	17 Aug 1965	24 Jan 1985		
	Remarks	Displayed at the Air Force Flight Test Center Museum, Edwards AFB, CA.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7956	2007			Gilliland/Belgau	3,760
	Remarks	Displayed at the Kalamazoo Air Museum, Kalamazoo, MI.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7957	2008	18 Dec 1965	11 Jan 1968	Gilliland/Eastham	?
	Remarks	SR-71B crashed 11 Jan 1968: instructor pilot Robert Sowers and student Dave Fruehauf both survived.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7958	2009	15 Dec 1965	23 Feb 1990	Weaver/Andre	2, 288.9
	Remarks	Displayed at the Museum of Aviation, Robbins AFB, GA.			

Tail No.	LAC No.	First Flight	Last Flight	First Flt Crew	Total Hours
61-7959	2010	19 Jan 1966	29 Oct 1976	Weaver/Andre	866.1
	Remarks	Displayed at the Air Force Armament Museum, Eglin AFB, FL.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7960	2011	9 Feb 1966	27 Feb 1990	Weaver/Andre	2, 699.6
	Remarks	Displayed at the Castle Air Museum Foundation, Castle AFB, CA.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7961	2012	13 Apr 1966	2 Feb 1977	Weaver/Andre	1,601
	Remarks	Displayed at the Cosmosphere and Space Center, Hutchison, KS.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7962	2013	29 Apr 1966	14 Feb 1990	Weaver/Belgau	2,835.9
	Remarks	Displayed at the Imperial War Museum, Duxford, UK.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7963	2014	9 Jun 1966	28 Oct 1976	Weaver/Belgau	1,604.4
	Remarks	Displayed at the Heritage Park, Beale AFB, CA.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7964	2015	11 May 1966	20 Mar 1990	Weaver/Belgau	3,373
	Remarks	Displayed at the Strategic Air and Space Museum, Ashland, NE.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7965	2016	10 Jun 1966	25 Oct 1976	Weaver/Moeller	?
	Remarks	Crashed 25 Oct 1967: both pilot Roy St Martin and RSO John Carnochan survived.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7966	2017	1 Jul 1966	13 Apr 1967	Gilliland/ Belgau	?
	Remarks	Crashed 13 April 1967: both pilot Earle Boone and RSO 'Butch' Sheffield survived.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7967	2018	3 Aug 1966	14 Feb 1990	Weaver/Andre	236.8
	Remarks	Displayed at the Barksdale Global Power Museum, Barksdale AFB Museum, LA.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7968	2019	3 Aug 1966	12 Feb 1990	Weaver/Andre	2,279
	Remarks	Displayed at the Virginia Aviation Museum, Richmond, VA.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7969	2020	18 Oct 1966	10 May 1970	Weaver/Belgau	?
	Remarks	Crashed 10 May 1970: pilot Willie Lawson and RSO Gil Martinez survived.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7970	2021	21 May 1966	17 Jun 1970	Weaver/Belgau	?
	Remarks	Crashed 17 June 1970: pilot Buddy Brown and RSO Mort Jarvis survived.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7971	2022	17 Nov 1966	Still flying	Weaver/Moeller	3,512.5
	Remarks	Displayed at the Evergreen Aviation & Space Museum, McMinnville, OR.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-17972	2023	12 Dec 1966	6 Mar 1990	Weaver/Belgau	2801
	Remarks	Displayed at the Udvar-Hazy Gallery, Smithsonian Air and Space Museum, Chantilly, VA.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
64-7973	2024	8 Feb 1967	21 July 1987	Weaver/Greenamyer	1,729.9
	Remarks	Displayed at the Blackbird Airpark, Palmdale, CA.			

Tail No.	LAC No.	First Flight	Last Flight	First Flt Crew	Total Hours
61-7974	2025	16 Feb 1967	21 April 1989	Weaver/Belgau	?
	Remarks	Crashed 21 April 1989: pilot Dan House and RSO Blair Bozek survived.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7975	2026	13 Apr 1967	28 Feb 1990	Greenamyer/Belgau	2,854
	Remarks	Displayed at March Field Museum, Riverside, CA.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7976	2027	? May 1967	27 Mar 1990	Gilliland/Belgau	2,985.7
	Remarks	Displayed at the National Museum of the US Air Force, Wright-Patterson AFB, OH.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7977	2028			Gilliland/Greenamer	
	Remarks	Written off 10 Oct 1968: pilot 'Abe' Kardong and RSO Jim Kogler survived.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7978	2029			Weaver/Belgau	
	Remarks	Written off 20 July 1972: pilot Deny Bush and RSO Jimmy Fagg survived.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7979	2030	10 Aug 1967	6 Mar 1990	Greenmyer/Belgau	3,321.7
	Remarks	Displayed at the History and Traditions Museum, Lackland AFB, TX.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7980	2031	25 Sep 1967	5 Feb 1990	Gilliland/Belgau	2,255.6
	Remarks	Displayed at the NASA Dryden Flight research Centre, Edwards AFB, CA.			
Tail No.	**LAC No.**	**First Flight**	**Last Flight**	**First Flt Crew**	**Total Hours**
61-7981	2000	14 Mar 1969	11 Apr 1976	Gilliland/Belgau	556.4
	Remarks	So-called SR-71C, trainer replacement, displayed at Hill AFB, UT.			

APPENDIX 6 SR-71 COMMANDERS AND AWARDS

9TH SRW COMMANDERS

Name	From	To
Col Douglas T. Nelson	Jan 1966	Dec 1966
Col William R. Hayes	Jan 1967	Jun 1969
Col Charles E. Minter	Jun 1969	Jun 1970
Col Harold E. Confer	Jul 1970	May 1972
Col Jerome F. O'Malley	May 1972	May 1973
Col Patrick J. Halloran	May 1973	Jun 1975
Col John H. Storrie	Jul 1975	Sep 1977
Col Lyman M. Kidder	Sep 1977	Jan 1979
Col Dale Shelton	Feb 1979	Jul 1980
Col David Young	Jul 1980	Jul 1982
Col Thomas S. Pugh	Jul 1982	Jul 1983
Col Hector Freese	Aug 1983	Jan 1985
Col David H. Pinsky	Jan 1985	Jul 1987
Col Richard H. Graham	Jul 1987	Nov 1988
Col James Savarda	Dec 1988	Jun 1990
Col Thomas J. Keck	Jun 1990	Nov 1991
Col Richard Young	Nov 1991	Jun 1993
Col Larry Tieman	Jun 1993	Jul 1994
Gen John Rutledge	Jul 1994	Sep 1995
Gen Robert Behler	Sep 1995 (Final SR-71)	

9TH SRW VICE WING COMMANDERS

Name	From	To
Col Marvin L. Speer	Jan 1966	Dec 1966
Col Charles F. Minter	Dec 1966	Jun 1969
Col Harold E. Confer	Jun 1969	Jun 1970
Col James E. Anderson	Jul 1970	Dec 1971
Col Dennis B. Sullivan	Dec 1971	Jul 1972
Col Patrick J. Halloran	Jul 1972	Jun 1973
Col Donald A. Walbrecht	Jun 1973	May 1974
Col John H. Storrie	Jun 1974	Jun 1975
Col Robert D. Beckel	Jun 1975	Sep 1976
Col Lyman M. Kidder	Oct 1976	Sep 1977
Col William E. Lawson III	Sep 1977	Jan 1979
Col David G. Young	Feb 1979	Jul 1980
Col Thomas S. Pugh	Jul 1980	Jul 1982
Col Lonnie S. Liss	Jul 1982	Jan 1983
Col David H. Pinsky	Jan 1983	Jan 1985
Col Robert B. McConnell	Jan 1985	Jun 1986
Col Richard H. Graham	Jun 1986	Jul 1987

Col Donald R. Schreiber	Aug 1987	Aug 1989
Col Tom Atkinson	Aug 1989	Jun 1990
Col Rich Salsbury	Jun 1990	Jul 1991
Col Rich Young	Jul 1991	Nov 1991
Col Larry Tieman	Nov 1991	Jun 1993
Col Buz Carpenter	Jun 1993	Jan 1995
Col George Lafferty	Jan 1995	Aug 1995
Col Dale Smith	Aug 1995 (Final SR-71)	

1ST STRATEGIC RECONNAISSANCE SQUADRON COMMANDERS

Name	From	To
Lt-Col William R. Griner	Jan 1966	Mar 1966
Lt-Col Harold E. Confer	Apr 1966	Oct 1966
Lt-Col Raymond Haupt	Nov 1966	Jul 1967
Lt-Col Alan L. Hichew	Jul 1967	Sep 1968
Lt-Col Patrick J. Halloran	Sep 1968	Nov 1969
Lt-Col James L. Watkins	Dec 1969	Mar 1971
Lt-Col Harlon A. Hain	Apr 1971	Jul 1971
Lt-Col Larry S. DeVall	Jul 1971	Jan 1972
Lt-Col Kenneth S. Collins	Jan 1972	Jun 1972
Lt-Col George M. Bull	Jun 1972	Jul 1973
Lt-Col Brian K. McCallum	Jul 1973	Jan 1974
Lt-Col James H. Shelton Jr	Jan 1974	Aug 1975
Lt-Col Raphael S. Samay	Aug 1975	Jun 1977
Lt-Col Adolphus H. Bledsoe	Jul 1977	Dec 1978
Lt-Col Randolph B. Hertzog	Dec 1978	Dec 1979
Lt-Col Richard H. Graham	Jan 1980	Jul 1981
Lt-Col Eldon W. Joersz	Aug 1981	Jul 1983
Lt-Col Alan B. Cirino	Jul 1983	Aug 1985
Lt-Col Joseph Kinego	Aug 1985	Aug 1987
Lt-Col William D. Orcutt	Aug 1987	Nov 1988
Lt-Col William R. Dyckman	Nov 1988	Jun 1990

99TH STRATEGIC RECONNAISSANCE SQUADRON COMMANDERS

Name	From	To
Lt-Col John B. Boynton	Jun 1966	Dec 1967
Lt-Col Robert G. Sowers	Jan 1967	Mar 1968
Lt-Col John C. Kennon	Apr 1968	Nov 1969
Lt-Col Harlon A. Hain	Nov 1969	Mar 1971

DETACHMENT 2 COMMANDER, EDWARDS AIR FORCE BASE

Name	From	To
Col Stan Gudmundson	Oct 1995	Jun 1998

9TH SRW AWARDS DURING SR-71 OPERATIONS

PRESIDENTIAL UNIT CITATION	31 Mar 1968	31 Dec 1968
AIR FORCE OUTSTANDING UNIT AWARD	1 Jul 1970	30 Jun 1971
AIR FORCE OUTSTANDING UNIT AWARD, WITH 'VALOR	1 Jul 1972	30 Jun 1973
AIR FORCE OUTSTANDING UNIT AWARD	1 Jul 1974	30 Jun 1975
AIR FORCE OUTSTANDING UNIT AWARD	1 Jul 1975	30 Jun 1977
AIR FORCE OUTSTANDING UNIT AWARD	1 Jul 1981	30 Jun 1982
AIR FORCE OUTSTANDING UNIT AWARD	1 Jul 1983	30 Jun 1984
AIR FORCE OUTSTANDING UNIT AWARD	1 Jul 1985	30 Jun 1986
AIR FORCE OUTSTANDING UNIT AWARD	1 Jul 1986	30 Jun 1987
OL-8 was also awarded the: REPUBLIC OF VIETNAM GALLANTRY CROSS & PALM, 31 Dec 1970		

APPENDIX 7 AIR FORCE LOGISTICS COMMAND SR-71 FLIGHT CREW HISTORY

Pilots	From	To
Merv Evenson	Jan 1970	Jul 1974
Dick Gerard	Jan 1971	Jul 1973
Tom Pugh	Jul 1973	Jul 1978
T. Smith	Oct 1973	Jul 1975
B. Riedenauer	Nov 1973	Nov 1978
Jim Sullivan	Jul 1978	Aug 1980
Cal Jewett	Jul 1978	Jul 1982
Bob Helt	Jul 1980	Jul 1984
Tom Tilden	Feb 1982	Jul 1989
B. C. Thomas	Jul 1984	Dec 1987
Ed Yeilding	Jan 1988	Jan 1990
J. Halsell	Feb 1989	Jan 1990

RSO	From	To
Col Red McNeer	Jan 1970	Jul 1971
Ron Selberg	Jan 1971	Aug 1974
Coz Mallozzi	Jul 1971	Jul 1974
B. Frazier	Jul 1974	Jul 1980
John Carnochan	Aug 1974	Feb 1978
George Morgan	Jan 1978	Jul 1985
Bob Flanagan	Jan 1980	Aug 1985
Joe Vida	Jan 1981	Jan 1990
P. Soucy	Jul 1985	Dec 1987
Tom Fuhrman	Dec 1987	Jan 1990

APPENDIX 8 CHRONOLOGY

1955	
4 August	First scheduled flight of the Lockheed U-2 completed at Area 51.
1956	
15 February	Lockheed Skunk Works begins work on Project Suntan for the US Air Force.
20 June	First CIA U-2 overflight of the Soviet Union.
10 July	First protest letter delivered to President Eisenhower following five U-2 incursions of Soviet sovereign airspace.
16 August	Project Rainbow begins in an attempt to render the U-2 'invisible to Soviet radar'.
1957	
24 December	Christmas Eve: first J58 engine run.
1958	
January	Classified cryptonym Gusto assigned to phase two of Project Rainbow as design work begins to find a U-2 replacement.
February	Project Suntan is cancelled at Kelly Johnson's instance.
Spring	CIA invites Convair to participate in Project Gusto
1959	
29 August	Lockheed's A-12 design declared winner of Project Gusto competition and an advanced feasibility contract is awarded for what becomes Project Oxcart.
1960	
16/17 March	Kelly Johnson discusses the possibility of building an interceptor version of the A-12 for the US Air Force with the Air Force Secretary for R&D.
1 May	U-2 flown by CIA pilot Francis Gary Powers is shot down and captured during a clandestine overflight by a Soviet SA-2 Guideline Surface to Air Missile (SAM).
October	Lockheed receives letter to proceed with development of YF-12A interceptor in a programme codenamed Kedlock.
1961	
January	Kelly Johnson proposes RB-12 (RB for Reconnaissance Bomber) to USAF – this evolved into the RS-12 (RS for Reconnaissance Strike) but was a 'paper only' aircraft, i.e. a prototype was never built.
1962	
30 April	Lockheed Chief Test Pilot Lou Schalk successfully completes the A-12's first official flight. Due to early development problems, the aircraft was powered by two Pratt & Whitney J75 engines.
4 June	SR-71 mock-up reviewed by Air Force
30 July	J58 completes pre-flight rating tests.
10 October	Skunk Works receives authorization to begin studies into building an unpiloted Mach3+ drone, which evolved into the D-21.
27 October	USAF pilot Major Anderson shot down and killed by another SA-2 SAM while flying a U-2 over Cuba during the missile crisis.
6 December	Kelly Johnson begins work on his R-12 'Universal' aircraft. It was this design that was later designated SR-71.
1963	
15 January	First flight of an A-12 powered by two Pratt & Whitney J58 engines completed.
18 February	Lockheed awarded pre-contractual authority to build six R-12s (SR-71s) on the understanding that orders for an additional 25 would follow before 1 July.
24 May	First A-12 is lost during a test sortie – Ken Collins the CIA pilot safely ejects.
7 August	Jim Eastham successfully completes the first flight of a YF-12 from Area 51.
1964	
29 February	President Lyndon B. Johnson announces the existence of the 'A-11' (A-12) programme.
25 July	President Lyndon B. Johnson makes a second announcement confirming the existence of the SR-71 programme.
29 October	SR-71 prototype Article 2001 delivered to Palmdale.
7 December	Announcement that SR-71s are to be based at Beale AFB.
18 December	First engine run of prototype SR-71/J58s conducted at Palmdale.
21 December	SR-71 conducts taxi tests.
22 December	First flight of Tagboard D-21/M-21 combination flight from Area 51 by Bill Park.
22 December	First flight of SR-71 prototype from Palmdale by Bob Gilliland.

1965	
3 March	First flight of NASA 'YF-12C'
18 March	YF-12A first AIM-47 missile.
1 May	YF-12A used to set nine world speed and altitude records.
1 June	SR-71/YF-12 Test Force formed at Edwards AFB.
7 July	First two T-38 companion trainers delivered to Beale AFB.
2 November	SR-71B maiden flight from Palmdale: pilot Bob Gilliland with Bill Weaver.
1966	
6 January	SR-71B pilot trainer delivered to USAF, flown by Ray Haupt and Charlie Bock.
7 January	SR-71B delivered to Beale by Ray Haupt and Doug Nelson.
25 January	First SR-71 is lost during Lockheed test sortie: pilot Bill Weaver survives but flight test engineer Jim Zwayer is killed.
10 May	First SR-71A delivered to 4200 SRW at Beale AFB.
25 June	4200 SRW redesignated 9 SRW.
3 July	First D-21 launched from M-21.
30 July	D-21/M-21 Tagboard programme terminated.
1967	
22 May	First of three A-12s deployed from Area 51 to Kadena AB, Okinawa, as part of Operation *Black Shield* to monitor North Vietnam.
31 May	Mele Vojvodich successfully completes the first ever operational mission on an A-12 in aircraft 60-6937 (Article 131).
1968	
5 January	Lockheed receives notification from US Air Force to cancel the YF-12A Kedlock programme.
11 January	SR-71B 61-7957 lost on approach to Beale.
26 January	First overflight of North Korea in A-12 made by Jack Weeks in aircraft 60-6937 (Article 131).
8 March	First of three SR-71As deployed on detachment to Kadena AB, Okinawa, ready for their first operational missions.
21 March	Majors Jerry O'Malley and his RSO Ed Payne successfully complete the first ever SR-71 mission in aircraft 61-7976.
25 May	Following 20 months of prevarication, a decision to terminate the A-12 Oxcart programme in favour of the SR-71 Senior Crown programme was finally endorsed by President Johnson and implemented.
26 July	First confirmed firing of two North Vietnamese SA-2s against an SR-71.
1 November	9th SRW receives the Air Force Outstanding Unit Award.
1969	
14 March	First flight of SR-71C – replacement pilot trainer.
13 April	9th SRW loses its first SR-71A.
1970	
16 January	SR-71/YF-12 Test Force redesignated 4786th Test Squadron.
11 December	YF-12 NASA/USAF test programme begins.
1971	
1 April	99th SRS deactivated as an SR-71 unit.
26 April	SR-71A completes 15,000-mile non-stop flight around US in 10 hours 30 minutes.
1973	
12/13 October	The first of nine SR-71 non-stop missions from the US East Coast to the Middle East and back is successfully completed during the Yom Kippur War.
1974	
1 September	Current world speed records New York–London established by crews flying SR-71A serial 61-7972.
13 September	Current world speed records London–Los Angeles established by crews flying SR-71A serial 61-7972.
1976	
27/28 July	SR-71A serial 61-7958 establishes a series of world speed and altitude records.
6 September	Majors Rich Graham and Don Emmons complete the first SR-71A operational mission from the UK in aircraft 61-7962.
1978	
16 November	First SR-71 overflight of Cuba.

1979	
31 March	Det 4 of the 9th SRW formed at RAF Mildenhall.
31 October	NASA flight test programme ended.
7 November	YF-12A lands at Wright-Patterson AFB for US Air Force Museum.
1981	
1 August	4029th SRTS formed at Beale AFB to train SR-71 crews.
26 August	North Korea fires an SA-2 in an attempt to shoot down SR-71A 61-7976.
1984	
7 November	First SR-71 mission over Nicaragua.
1986	
13 April	The first of three SR-71A flights is successfully completed from the UK over Libya following Operation El Dorado Canyon.
1987	
22 July	First operational SR-71 flight from Kadena into the Gulf completed
1989	
1 October	All USAF SR-71 operations suspended (except for minimum proficiency training sorties) while awaiting budget decision.
22 November	All USAF SR-71 operations terminated.
1990	
26 January	SR-71 decommissioned in ceremony at Beale AFB.
6 March	SR-71A 61-7972 flown by Lt Col Ed Yeilding and Lt Col J. T. Vida establishes current world speed record between the west and east coasts of the USA during positioning flight to Dulles Airport prior to being displayed at the Smithsonian Museum.
1995	
5 January	Limited reactivation plan for three SR-71s begins.
1996	
16 April	USAF once again suspends all SR-71 operations.
1997	
10 October	Final USAF SR-71 flight flown in 61-7967.
14 October	President Clinton line-item vetoes the limited SR-71 programme with immediate effect.
1999	
6 October	Detachment 2 of the 9th SRW deactivated.
9 October	NASA crew Rogers Smith and Bob Meyer flies SR-71A 61-7980 on the type's final flight at the Edwards AFB Open Day.

APPENDIX 9 RECORDS

While reading the records established below that were verified at the time by the Federation Aeronautique Internationale (FAI), it should be remembered that impressive as these figures are, they are not demonstrations of the aeroplane's absolute capabilities. For example, on 20 November 1965, an A-12 attained speeds in excess of Mach 3.2 and a sustained altitude capability above 90,000ft. During the first operational deployment of a CIA A-12 from Area 1 to Kadena Air Base on the island of Okinawa, pilot Mele Vojvodich covered the distance in aircraft article number 131 in just 6 hours 6 minutes; had it not been for security considerations, this could easily have been recognised as a new transpacific speed record. With the passage of time, several earlier SR-71 records were broken by a highly modified stripped-down Soviet MiG-25. However, the inability of that country to subsequently build an operational aircraft that represented a serious threat to the SR-71 provides a useful perspective on the research-only status of that particular jet.

▼ Despite two aircraft being prepared for the 1 May 1965 record attempts, in the event YF-12A 60-6936 secured all of them. It is seen here climbing away with the gear being retracted and the centreline fin beginning to extend. (Lockheed Martin via Tony Landis)

YF-12A RECORDS

It's probably not a coincidence that the date chosen to demonstrate some of the YF-12's awesome capabilities was 1 May 1965 – exactly five years to the day after Francis Gary Powers was shot down by a Soviet SA-2 SAM while conducting an overflight in his U-2.

Record: Absolute altitude: 80,257.9ft.
Crew: Pilot Col Robert L. 'Fox' Stephens, Fire Control Officer (FCO) Lt Col Daniel Andre
Aircraft: YF-12A, 60-6936
Record: Absolute speed over a straight course: 2,070.1mph
Crew: Pilot Col Robert L. 'Fox' Stephens, FCO Lt Col Daniel Andre
Aircraft: YF-12A, 60-6936
Record: Absolute speed over a 500km closed course: 1,688.9mph
Crew: Lt Col Walter F. Daniel, FCO Maj James P. Cooney
Aircraft: YF-12A, 60-6936
Record: Absolute Speed over a 1,000km closed course: 1,643.0mph
Crew: Pilot Lt Col Walter F. Daniel, FCO Maj Noel T. Warner
Aircraft: YF-12A, 60-6936

◀ Col Robert L. 'Fox' Stephens and his FCO, Lt Col Daniel Andre, set new absolute altitude and absolute speed records on 1 May 1965. (USAF)

SR-71 RECORDS

The first big SR-71 attention-grabbing headline was undoubtedly the transatlantic speed records: they both still stand unbroken over 40 years later.

Record: 1 Sept 1974. New York to London.
Distance: 3,461.5 miles. Time 1hr 54mins 56.4secs
Crew: Pilot Maj James V. Sullivan, RSO Maj Noel F. Widdifield
Aircraft: SR-71A, 61-7972
Record: 13 Sept 1974. London to Los Angeles
Crew: Pilot Capt Harold B. (Buck) Adams, RSO Capt William C. Machorek
Distance: 5446.9 miles. Time 3hrs 47mins 39secs
Aircraft: SR-71A, 61-7972

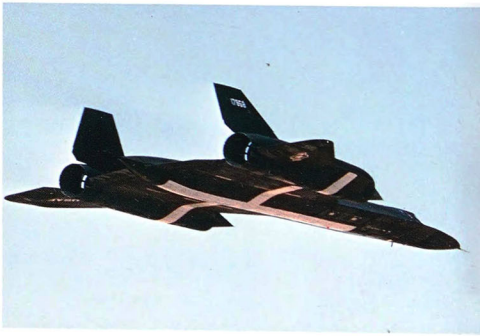
▲ The current New York to London transatlantic speed record was set back in 1974 by SR-71A 61-7972, after which it recovered into Farnborough. (Lockheed Martin via Tony Landis)

▲ Majors Jim Sullivan (left) and his RSO Noel Widdifield still retain their world speed record over 40 years later. (USAF)

Next came the US bicentennial celebrations of 1976, whi provided the 9th SRW with another opportunity to break thr more world absolute records. It was hoped that the attemp would be made on 4 July, but due to administrative delays th were scheduled for 27/28 July. Three crews and two aircraft (6 7958 and 61-7962) were made ready for the attempts.

Record: 27 July 1976. Speed over a closed course of 1,000km: 2,092.3mph.
Crew: Majors Adolphus Bledsoe and RSO John Fuller.
Aircraft: SR-71A, 61-7958
Note: cloud prevented the Nun Baker tracking cameras from recording the other flights throughout their entire course – a prerequisite insisted upon by the FAI.
Record: 28 July 1976. Speed over a straight course (15-25km): 2,193.2mph.
Crew: Captain Eldon W. Joersz and RSO Major George T. Morgan.
Aircraft: SR-71A, 61-7958
Record: 28 July 1976. Altitude in horizontal flight: 85,069ft.
Crew: Captain Robert C. Helt and RSO Major Larry A. Elliott.
Aircraft: SR-71A, 61-7958
Note: this crew strapped into 61-7962 to rerun their altitude attempt of the previous day. However due to a maintenance issue they ground aborted and switched into 61-7958, so it was in this aircraft that they established their record.

Finally, despite all that some Strategic Air Command officia could do to prevent more headline attention after the Seni Crown programme was prematurely closed down.



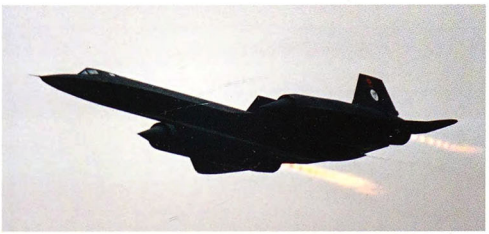
▲ Weather and a mechanical malfunction conspired to ensure that all July 1976 records were set by 61-7958. The cross was applied to the underside to assist ground-based tracking cameras. (Lockheed Martin v Tony Landis)

BLACKBIRD RECORDS: 6 MARCH 1990

On the delivery mission to the Smithsonian Institution, where the aircraft is displayed at the Smithsonian's Udvar-Hazy Center near Dulles International Airport, the current west coast to east coast world speed record was set (a distance of 2,404.05 miles).

WEST COAST TO EAST COAST (2,404.05 MILES)	
Time	**Average speed**
1hr 07mins 53.7secs	2,124.51mph
LOS ANGELES TO WASHINGTON DC (2,299.67 MILES)	
Time	**Average speed**
1 hour 4 minutes 20 seconds	2,144.83mph
ST LOUIS TO CINCINNATTI (311.44 MILES)	
Time	**Average Speed**
8 minutes 32 seconds	2,189.94mph

KANSAS CITY TO WASHINGTON DC (942.08 MILES)			
Time	**Average speed**	**Aircraft**	**Crew**
25 minutes 58.5 seconds	2,176.08mph	SR-71A, 61-7972	Pilot Lt Col Ed Yeilding, RSO Lt Col Joseph T. Vida



▲ Lt Col Ed Yeilding and his RSO Lt Col J. T. Vida congratulate one another after having established the current world speed record between the US west and east coast – 1 hour, 7 minutes 53 seconds. (Lockheed Martin via Tony Landis)

General Al Joersz, a captain at the time of setting his 1976 record, recalls the event:

The record-breaking flight was flown out of Beale AFB, unrefuelled, down to and over the Edwards AFB ranges and back. The criteria for breaking the record included the requirement to fly through a 25km course in level flight (we had to exit the course within 150ft of the entry altitude). After entering, we completed a 90/270 turn (which had us fly through three states, Arizona, Nevada and California): we then re-entered the course flying through in the opposite direction. In this instance the rules required that you again enter the course within 300ft of the first exit altitude and then leave within 150ft of the second entry altitude. While this may not seem like a big deal, flying at 80,600ft is was more difficult than is readily apparent. The SR-71 is a cruise climb airplane, so the desired altitude for each pass was considerably different. For the first pass we had to be higher than desired and during the second we had to be lower than desired (we actually had to throttle back to keep from exceeding the max design limit of the airplane on the second pass.) We actually flew for the record on the 27th, but since weather precluded accurate altitude measurement of our flight, we were required to fly it again on the 28th. That flight was tracked satisfactorily, as was the counter. Actually during the flight on the first day (the 27th) we had an inlet unstart midway through the course at 3.3 Mach, which made our ability to stay within the 150ft altitude requirement problematic. No one ever said we exceeded the limit, but it was close at least. An unstart at any speed and condition is always interesting, but the one that day was even more unwelcome than normal. The airplane is pretty delicate to fly while at max speed and altitude and that day was no exception.

We were selected to fly the mission pretty much at random. We were one of the more senior crews available and since there were only 9 qualified crews flying the airplane at that time and four of them were unavailable due to operational deployments, the chance of getting to do the record was pretty high. In any case, we were honoured and enjoyed the chance to put some new numbers in the books. We decided we would shoot for about 2,200mph, but our translation from nautical miles per hour [knots] to mph was a little off, so we ended up at 2,193 mph. Actually we flew the course at max compressor inlet temperature (CIT) limit for the airplane, so we didn't have much wiggle room to do more. The airplane we flew (tail number 958) was just one of the planes in the hangar. The only modification made was to paint a big white X on the bottom so that they could track us better with the cameras as we flew through the range at Edwards. (The Nun Baker cameras are the ones used to track the space shuttle when it comes in to land at Edwards and to photograph other test flights out of that facility).

APPENDIX 10 LOSSES

A-12

Article No.	Remarks
123	Crashed 24 May 1963: pilot Ken Collins survived.
125	Crashed 5 Jan 1967: pilot Walter Ray killed.
126	Crashed 28 Dec 1967: pilot Mel Vojvodich survived.
129	Crashed 5 June 1968: pilot Jack Weeks killed.
133	Crashed 9 July 1964: pilot Bill Park survived.

M-12

Tail No.	Article No.	Remarks
60-6941	135	Converted to M-21 to carry D-21 drone. Crashed 30 July 1966: pilot Bill Park survived, Launch Control Officer Ray Torick was killed.

YF-12A

Tail No.	Article No.	Remarks
60-6936	1003	Crashed 24 July 1971: pilot Lt Col Jack Layton and Fire Control Officer Maj Bill Curtis both survived.

SR-71

Tail No.	Article No.	Remarks
61-7950	2001	Written off on 10 Jan 1967: pilot Art Peterson survived.
61-7952	2003	Crashed 25 Jan 1966: pilot Bill Weaver survived, Lockheed test engineer Jim Zwayer was killed.
61-7953	2004	Crashed 18 Dec 1969: pilot Joe Rogers and RSO Gary Heidelbaugh both survived.
61-7954	2005	Written off 11 April 1969: pilot Lt Col Bill Skliar and RSO Maj Noel Warner both survived.
61-7957	2008	SR-71B, crashed 11 Jan 1968: instructor pilot Lt Col Robert Sowers and student Capt Dave Fruehauf both survived.
61-7965	2016	Crashed 25 Oct 1967: both pilot Maj Roy St Martin and RSO Maj John Carnochan survived.
61-7966	2017	Crashed 13 April 1967: both pilot Maj Earle Boone and RSO Maj 'Butch' Sheffield survived.
61-7969	2020	Crashed 10 May 1970: both pilot Maj Willie Lawson and RSO Maj Gil Martinez survived.
61-7970	2021	Crashed 17 June 1970: both pilot Maj Buddy Brown and RSO Mort Jarvis survived.
61-7974	2025	Crashed 21 April 1989: both pilot Maj Dan House and RSO Capt Blair Bozek survived.
61-7977	2028	Written off 10 Oct 1968: both pilot Maj 'Abe' Kardong and RSO Jim Kogler survived.
61-7978	2029	Written off 20 July 1972: both pilot Maj Dennis Bush and RSO Maj Jimmy Fagg survived.

ACRONYMS AND ABBREVIATIONS

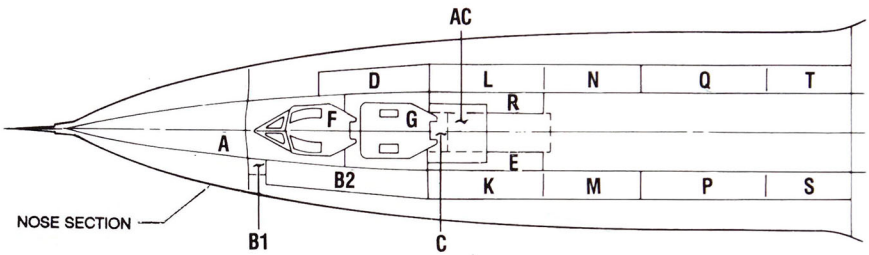
AAA:	Anti-Aircraft Artillery
AB:	Air Base
ACINT:	acoustic intelligence
ADC:	Aerospace Defense Command
ADF:	Automatic Direction Finder
ADI:	Attitude Director Indicator
ADP:	Advanced Development Programs
ADS:	Accessory Drive System
AEC:	Atomic Energy Commission
AFB:	Air Force Base
AFDAP:	USAF Development and Advanced Planning
AFLC:	Air Force Logistics Command
AFPAO:	Air Force Project Administrative Officer
AFQAR:	Air Force Quality Assurance Representative
AFLC:	Air Force Logistics Command
AFSC:	Air Force Systems Command
AGER:	Auxiliary General Environmental Research Ship
AICS:	Air Inlet Control System
AISG:	Air Intelligence Service Group
ALSS:	Advanced Location and Strike System
AMARG:	Aerospace Maintenance and Regeneration Group
ANS:	Astro-inertial Navigation System
APW:	Automatic Pitch Warning
ARC:	Ad-hoc Requirements Committee
ARCP:	Air Refuelling Control Point
ARDC:	Air Research and Development Command
AREFS:	Air Refuelling Squadron
ASARS:	Advanced Synthetic Aperture Radar System
ASD:	Aeronautical Systems Division
ASPO:	Advanced Systems Project Office
ATC:	Air Traffic Control
BDA:	Bomb Damage Assessment
BIT:	Built-In-Test
BoB:	Bureau of the Budget
CAP:	Combat Air Patrol
CAPA:	Central Airborne Performance Analyzer
CAPRE:	Capability Reconnaissance Radar
CCT:	Computer Compatible Tape
CDA:	Congressionally Directed Action
CDI:	Course Deviation Indicator
CEP:	Circular Error of Probability
CIA:	Central Intelligence Agency
CINC:	Commander in Chief
CINCPAC:	Commander in Chief Pacific
CINCATL:	Commander in Chief Atlantic
CINCPACFLT:	Commander in Chief, Pacific Fleet
CINCSAC:	Commander in Chief SAC
CIT:	Compressor Inlet Temperature
CIS:	Chemical Ignition System
Comint:	Communications Intelligence
COMIREX:	Committee on Imagery Requirements and Exploitation
COMUSKOREA:	Commander United States Forces Korea
COP:	Centre of Pressure
CP:	Command Post
CSD:	Constant Speed Drive
DAFICS:	Digital Automatic Flight Inlet Control System
DARPA:	Defense Advanced Research Projects Agency
DCI:	Director of Central Intelligence
DCRsi:	Digital Cassette Recorder System
DCS:	Decompression Sickness
DEF:	Defense Electronic System
Det:	Detachment
DIA:	Defense Intelligence Agency
DME:	Distance Measuring Equipment
DMZ:	Demilitarized Zone
DO:	Director of Operations
DoD:	Department of Defense
DP:	Destination Point
DPD:	Development Projects Division
DPP:	Deputy Director for Plans
DPS:	Development Projects Staff
DTG:	Distance To Go
EAR:	End Air Refuelling
ECM:	Electronic Counter-Measures
EDP:	Electronic Data Processing
EG&G:	Edgerton, Germeshausen & Grier
EGT:	Exhaust Gas Temperature
EIP:	ELINT Improvement Programme
ELINT:	Electronic Intelligence
EMR:	Electromagnetic Reconnaissance System
EOB:	Electronic Order of Battle
EWO:	Electronic Warfare Officer

FAA:	Federal Aviation Authority
FAI:	Federation Aeronautique Internationale
FCF:	Functional Check Flight
FCO:	Fire Control Officer
FCS:	Fire Control System
FINPAC:	Fleet Intelligence, Pacific
FISH:	First Invisible Super Hustler
FLC:	Flight Research Center
FLOT:	Forward Line of Own Troops
FMC:	Forward Motion Compensation
FOD:	Foreign Object Damage
FRS:	Flight Reference System
FY:	Fiscal Year
GCA:	Ground Controlled Approach
GCI:	Ground Controlled Intercept
HEF:	High Energy Fuel
HF/SSB:	High Frequency Single Side-Band
HRR:	High Resolution Radar
HIS:	Horizontal Situation Indicator
HSD:	Horizontal Situation Display
HUD:	Head Up Display
HULTEC:	Hull-to-Emitter Correlation
HUMINT:	Human Intelligence
IAC:	Intelligence Advisory Committee
IAP	Istrebitelniy Aviatsonniy Polk
ICPAC:	Intelligence Center Pacific
IFF:	Identification Friend or Foe
IFR:	Instrument Flight Rules
IGV:	Inlet Guide Vane
ILS:	Instrument Landing System
IMI:	Improved Manned Interceptor
INS:	Inertial Navigation System
IP:	Instructor Pilot
IPIR:	Initial Photographic Intelligence Report
IR:	Infrared
IRBM:	Intermediate Range Ballistic Missiles
IRST:	Infrared Search and Track
ISP:	Intelligence Systems Panel
IU:	Interface Unit
JCS:	Joint Chiefs of Staff
JTIDS:	Joint Tactical Information Distribution System
KEAS:	Knots Equivalent Airspeed
KIAS:	Knots Indicated Airspeed
LASRE:	Linear Aerospike SR-71 Experiment
LCO:	Launch Control Operator
MAC:	Mean Aerodynamic Chord
MAC:	Military Airlift Command
MACV:	Military Assistance Command Vietnam
MARS:	Mid-Air Retrieval System
MFD:	Multifunction Display
MGFU:	Mobile Ground Formatter Unit
MIRE:	Mission Intercept Report Electrical
MIA:	Missing In Action
MIT:	Massachusetts Institute of Technology
MLG:	Main Landing Gear
MoU:	Memorandum of Understanding
MPC:	Mobile Processing Center
MRBM:	Medium Range Ballistic Missiles
MRS:	Mission Recorder System
NACA:	National Advisory Committee for Aeronautics
NASA:	National Aeronautics and Space Administration
NATO:	North Atlantic Treaty Organization
NIE:	National Intelligence Estimate
NLG:	Nose Landing Gear
NOSIC:	Navy Ocean Surveillance Information Center
NOTAM:	Notice To Airman
NPIC:	National Photographic Interpretation Center
NRO:	National Reconnaissance Office
NSA:	National Security Agency
OBC:	Optical Bar Camera
ODM:	Office of Defence Mobilisation
OIC:	Officer In Charge
OL:	Operating Location
OMB:	Optical Multifunctional Apparatus
ONI:	Office of Naval Intelligence
OOC:	Operational Objective Camera
OPIC-A:	Overseas Processing and Interpretation Centre – Asia
OR:	Operationally Ready
OSA:	Office of Special Activities (CIA)
OSI:	Office of Scientific Intelligence
OSF:	Orders for Safe Flight
ORI:	Operational Readiness Inspection
PACAF:	US Pacific Air Force Command
PAR:	Precision Approach Radar
PARPRO:	Peacetime Aerial Reconnaissance Programme
PCS:	Permanent Change of Station
PDM:	Periodic Depot Maintenance
PEM:	Programme Element Monitor
PHOTINT:	Photographic Intelligence
PI:	Photo Interpreter
PIP:	Product Improved Radar

PK:	Probability of Kill
PLO:	Palestine Liberation Organization
PLOC:	Pre-launch Operational Check
PMR:	Pacific Missile Range
POW:	Prisoner of War
PRI:	Pulse Repetition Interval
PRF:	Pulse Repetition Frequency
PSD:	Physiological Support Division
PVHD:	Peripheral Vision Horizon Display
PVO:	Protivovodushnaya Oborona Strany
RADINT:	Radar Intelligence
RAF:	Royal Air Force
RAM:	Radar Absorbent Material
RB:	Reconnaissance Bomber
RCD:	Radar Correlator Display
RCS:	Radar Cross Section
R&D:	Research and Development
RGPO:	Range Gate Pull-Off
RHAWR:	Radar Homing and Warning Receiver
RS:	Reconnaissance Strike
RSO:	Reconnaissance Systems Officer (NASA only, Research Systems Operator)
RTAFB:	Royal Thailand Air Force Base
RTS:	Reconnaissance Technical Squadron
SAC:	Strategic Air Command
SAFE:	Semi-Automatic Ferret Equipment
SALSA:	Special Assistant for Counterinsurgency and Special Activities
SAM:	Surface to Air Missile
SAS:	Stability Augmentation System
SCIF:	Special Compartmented Intelligence Facility
SDV:	Swimmer Delivery Vehicle
SEBER:	Special ELINT Beacon Receiver
SEI:	Scientific Engineering Institute
SFC:	Specific Fuel Consumption
SIGINT:	Signals Intelligence
SIOP:	Single Integrated Operational Plan
SLAR:	Side-Looking Airborne Radar
SLBM:	Submarine Launched Ballistic Missiles
SLOC:	Sea Lines of Communication
SOP:	Standard Operating Procedure
SOSUS:	Sound Surveillance System
SPO:	System Project Officer
SRA:	Special Operations Area
SRC:	Strategic Reconnaissance Center
SRG:	Strategic Reconnaissance Group
SRO:	Senior Ranking Officer
SRS:	Strategic Reconnaissance Squadron
SRW:	Strategic Reconnaissance Wing
SSM:	Surface to Surface Missile
SST:	Supersonic Transport;
Stan/Eval:	Standardization and Evaluation
TACAN:	Tactical Air Navigation
TCU:	Tape Copy Unit
TEB:	Tri-ethyl Borane
TEOC:	Technical Objective Camera
TCP:	Technological Capabilities Panel
TDI:	Triple Display Indicator
TDY:	Temporary Duty
TIARA:	Tactical Intelligence and Related Activities
TIT:	Turbine Inlet Temperature
TROC:	Terrain Objective Camera
UHF:	Ultra High Frequency
UCD:	Urine Collection Device
USAF:	United States Air Force
USAFE:	United States Air Forces Europe
USIB:	United States Intelligence Board
USSR:	Union of Soviet Socialist Republics
V/H:	Velocity/Height
VFR:	Visual Flight Rules
WESTPAC:	Western Pacific
WSO:	Weapons System Operator
XOORZ:	Air Staff Operations Division

TECHNICAL DIAGRAMS

NOSE BAY ARRANGEMENT OF THE LOCKHEED BLACKBIRD



COMPARTMENT DESIGNATION	FUSELAGE COMPARTMENT	ALTERNATE COMPARTMENT NOMENCLATURE
AC	AC-BAY	AIR CONDITIONING BAY
B1	B1-BAY	PRESSURE TRANSDUCER ASSEMBLY (PTA) BAY
B2	B2-BAY	LOX AND 3RD LN_2 SYSTEM ⚠1 COMPARTMENT
C	C-BAY	CENTER BAY
D	D-BAY	RIGHT CHINE BAY ⚠2
E	E-BAY	ELECTRICAL EQUIPMENT BAY
K	K-BAY	FWD LEFT PAYLOAD EQUIPMENT BAY, FWD END
L	L-BAY	FWD RIGHT PAYLOAD EQUIPMENT BAY, FWD END
M	M-BAY	FWD LEFT PAYLOAD EQUIPMENT BAY, AFT END
N	N-BAY	FWD RIGHT PAYLOAD EQUIPMENT BAY, AFT END
P	P-BAY	AFT LEFT PAYLOAD EQUIPMENT BAY, FWD END
Q	Q-BAY	AFT RIGHT PAYLOAD EQUIPMENT BAY, FWD END
R	R-BAY	RADIO EQUIPMENT BAY
S	S-BAY	AFT LEFT PAYLOAD EQUIPMENT BAY, AFT END
T	T-BAY	AFT RIGHT PAYLOAD EQUIPMENT BAY, AFT END

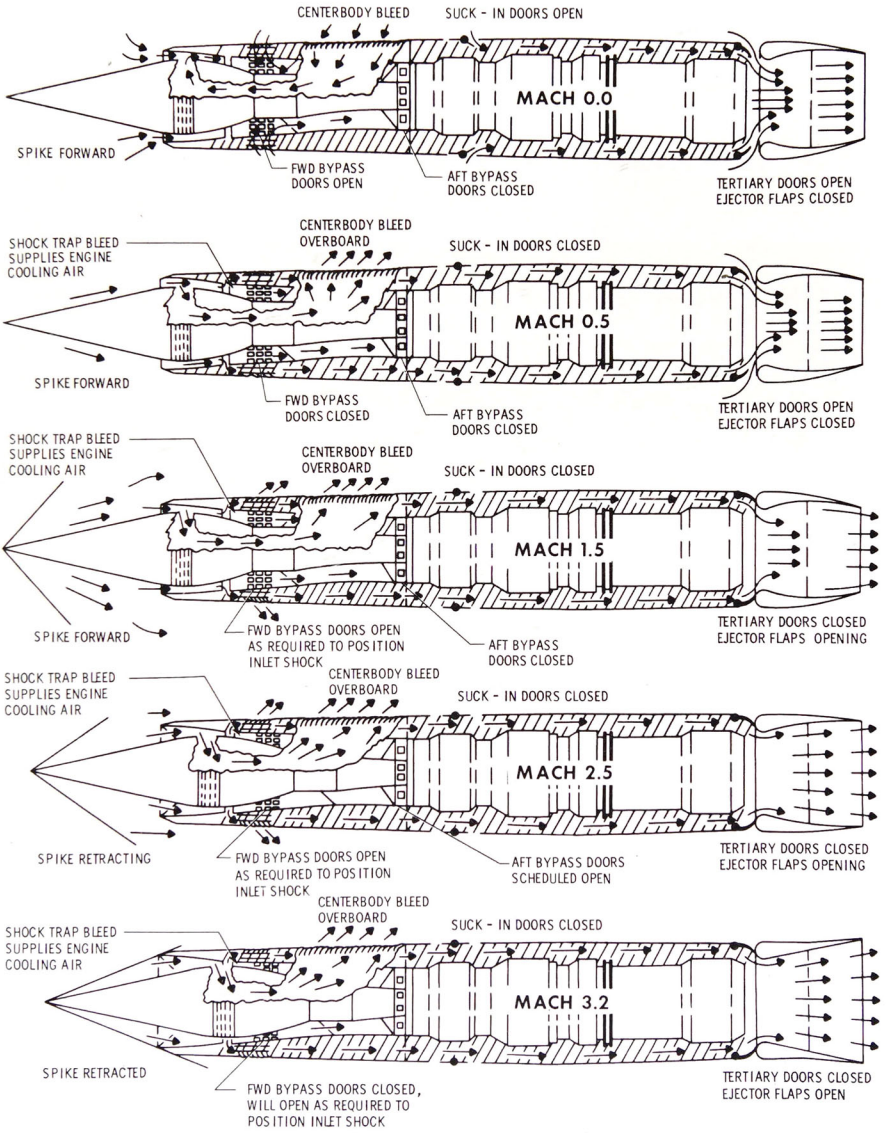
NOTE

⚠1 Third LN_2 system installed on SR-71A only.

⚠2 On SR-71 aircraft only.

3. All identified areas, except the AC, B1, B2, and E-bays, and for the most part the R-bay, can be used for internal payload installations.

LOCKHEED SR-71 INLET AIRFLOW DIAGRAM



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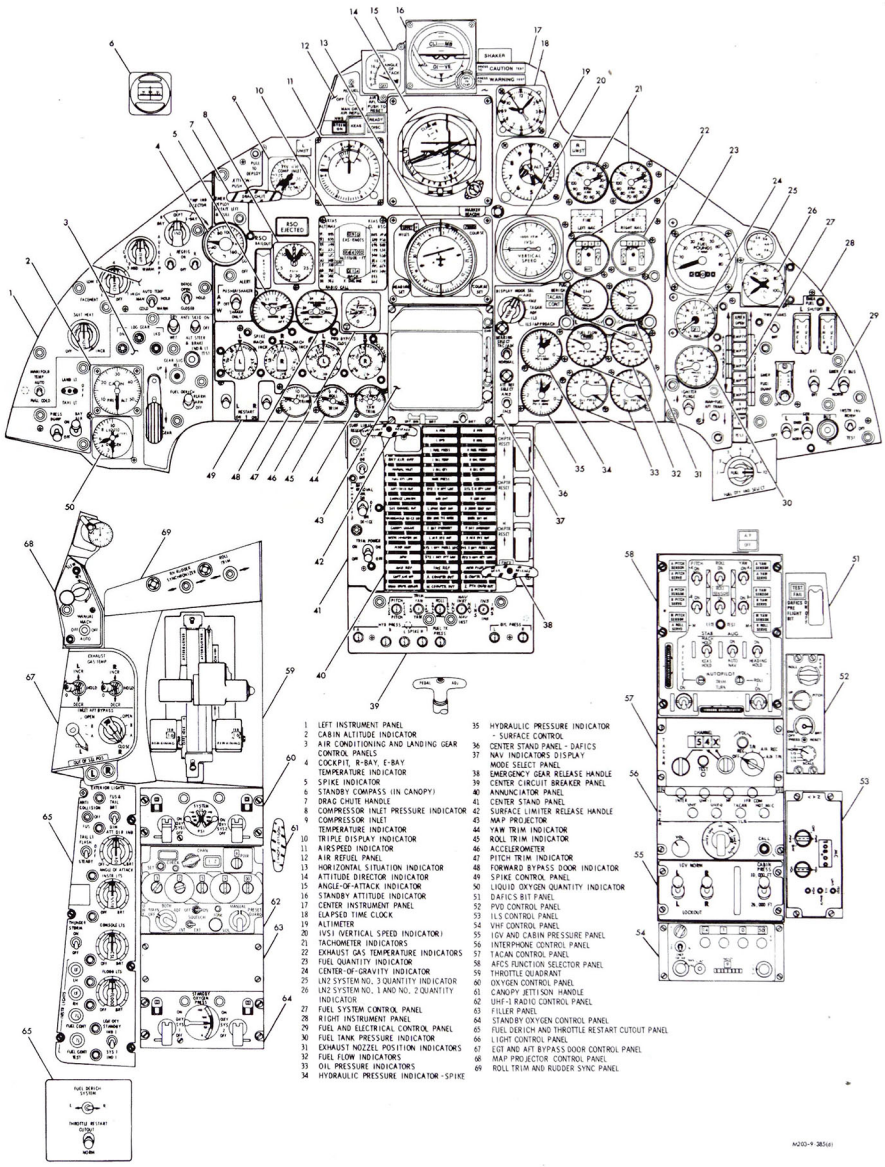
SR-71A FORWARD COCKPIT INSTRUMENT PANEL AND SIDE CONSOLES



1 LEFT INSTRUMENT PANEL
2 CABIN ALTITUDE INDICATOR
3 AIR CONDITIONING AND LANDING GEAR CONTROL PANELS
4 COCKPIT, R-BAY, E-BAY TEMPERATURE INDICATOR
5 SPIKE INDICATOR
6 STANDBY COMPASS (IN CANOPY)
7 DRAG CHUTE HANDLE
8 COMPRESSOR INLET PRESSURE INDICATOR
9 COMPRESSOR INLET TEMPERATURE INDICATOR
10 TRIPLE DISPLAY INDICATOR
11 AIRSPEED INDICATOR
12 AIR REFUEL PANEL
13 HORIZONTAL SITUATION INDICATOR
14 ATTITUDE DIRECTOR INDICATOR
15 ANGLE-OF-ATTACK INDICATOR
16 STANDBY ATTITUDE INDICATOR
17 CENTER INSTRUMENT PANEL
18 ELAPSED TIME CLOCK
19 ALTIMETER
20 IVSI (VERTICAL SPEED INDICATOR)
21 TACHOMETER INDICATORS
22 EXHAUST GAS TEMPERATURE INDICATORS
23 FUEL QUANTITY INDICATOR
24 CENTER-OF-GRAVITY INDICATOR
25 LN2 SYSTEM NO. 3 QUANTITY INDICATOR
26 LN2 SYSTEM NO. 1 AND NO. 2 QUANTITY INDICATOR
27 FUEL SYSTEM CONTROL PANEL
28 RIGHT INSTRUMENT PANEL
29 FUEL AND ELECTRICAL CONTROL PANEL
30 FUEL TANK PRESSURE INDICATOR
31 EXHAUST NOZZEL POSITION INDICATORS
32 FUEL FLOW INDICATORS
33 OIL PRESSURE INDICATORS
34 HYDRAULIC PRESSURE INDICATOR - SPIKE
35 HYDRAULIC PRESSURE INDICATOR - SURFACE CONTROL
36 CENTER STAND PANEL - DAFICS
37 NAV INDICATORS DISPLAY MODE SELECT PANEL
38 EMERGENCY GEAR RELEASE HANDLE
39 CENTER CIRCUIT BREAKER PANEL
40 ANNUNCIATOR PANEL
41 CENTER STAND PANEL
42 SURFACE LIMITER RELEASE HANDLE
43 MAP PROJECTOR
44 YAW TRIM INDICATOR
45 ROLL TRIM INDICATOR
46 ACCELEROMETER
47 PITCH TRIM INDICATOR
48 FORWARD BYPASS DOOR INDICATOR
49 SPIKE CONTROL PANEL
50 LIQUID OXYGEN QUANTITY INDICATOR
51 DAFICS BIT PANEL
52 PVD CONTROL PANEL
53 ILS CONTROL PANEL
54 VHF CONTROL PANEL
55 IGV AND CABIN PRESSURE PANEL
56 INTERPHONE CONTROL PANEL
57 TACAN CONTROL PANEL
58 AFCS FUNCTION SELECTOR PANEL
59 THROTTLE QUADRANT
60 OXYGEN CONTROL PANEL
61 CANOPY JETTISON HANDLE
62 UHF-1 RADIO CONTROL PANEL
63 FILLER PANEL
64 STANDBY OXYGEN CONTROL PANEL
65 FUEL DERICH AND THROTTLE RESTART CUTOUT PANEL
66 LIGHT CONTROL PANEL
67 EGT AND AFT BYPASS DOOR CONTROL PANEL
68 MAP PROJECTOR CONTROL PANEL
69 ROLL TRIM AND RUDDER SYNC PANEL

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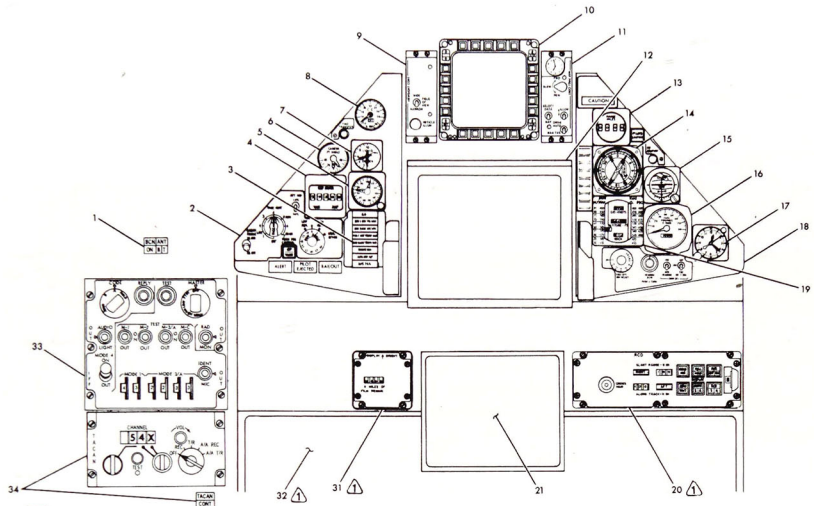
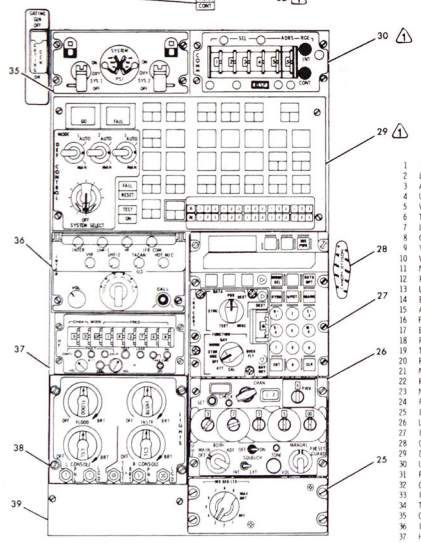
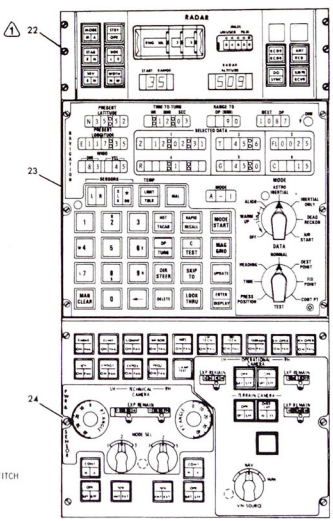
SR-71A AFT COCKPIT INSTRUMENT PANELS AND SIDE CONSOLES







1 BEACON CONTROL SWITCHES
2 LEFT INSTRUMENT PANEL
3 ANNUNCIATOR PANEL
4 UHF-1 REMOTE FREQUENCY INDICATOR
5 VHI INDICATOR
6 TEOC CAMERA POINT ANGLE INDICATOR
7 LIQUID OXYGEN QUANTITY INDICATOR
8 CENTER-OF-GRAVITY INDICATOR
9 VIEWSIGHT CONTROL PANEL
10 VIEWSIGHT DISPLAY
11 MAP PROJECTOR CONTROL PANEL
12 RADAR DISPLAY
13 UHF DISTANCE INDICATOR
14 BEARING DISTANCE HEADING INDICATOR
15 ATTITUDE INDICATOR
16 FUEL QUANTITY INDICATOR
17 ELAPSED TIME CLOCK
18 RIGHT INSTRUMENT PANEL
19 TRIPLE DISPLAY INDICATOR
20 RCD CONTROL PANEL
21 MAP PROJECTOR SCREEN
22 RADAR CONTROL PANEL
23 NAV CONTROL AND DISPLAY PANEL
24 POWER AND SENSOR CONTROL PANEL
25 INS LIGHTING CONTROL PANEL
26 UHF-2 RADIO CONTROL PANEL
27 INS CONTROL PANEL
28 CANOPY JETTISON HANDLE
29 DEF CONTROL PANEL
30 UHF MODEM
31 RCD FILM REMAINING PANEL
32 CAPRE RCD UNIT OR ASARS PROCESSOR
33 IFF CONTROL PANEL
34 TACAN CONTROL PANEL AND TRANSFER SWITCH
35 OXYGEN CONTROL PANEL
36 INTERPHONE CONTROL PANEL
37 HF RADIO CONTROL PANEL
38 LIGHT CONTROL PANEL
39 FILLER PANEL

NOTE

△1 Not available

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During his time at the London Air Traffic Control Centre, Paul F. Crickmore gained a unique introduction into SR-71 operations from RAF Mildenhall, Suffolk. Teaming up with Osprey, he produced the first detailed book ever to be published on the aircraft. When additional information became available to him in 1990 following the initial shutdown of SR-71 operations, Crickmore produced an even more detailed book, *Lockheed SR-71: The Secret Missions Exposed* – the standard reference work on the subject. The work was acclaimed by the aviation press, Ben Rich (late president of the Skunk Works) and the crews that flew the SR-71, and it was later updated to *Lockheed Blackbird: Beyond the Secret Missions*. He is also the author of the *Haynes Lockheed F-117A Nighthawk Manual*.

LOCKHEED BLACKBIRD

BEYOND THE SECRET MISSIONS

The Lockheed SR-71 Blackbird ranks as one of the most elegant, sleek and powerful aeroplanes ever designed. But it was not built to be admired – it was built not to be seen at all. The high-altitude aerial reconnaissance sorties it was to perform were top secret and carefully concealed from public knowledge. However, as the aircraft have become museum pieces and details of their work declassified, the whole story of their design and operation can finally be told.

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